ANATOMICAL AND PHYSIOLOGICAL

COMMENTARIES.

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Introductory Observations on a Vital Principle.

So much importance has been recently attached to inquiries respecting a Principle of Life, and the opinions maintained by different individuals have been so much at variance, that an impartial consideration of this subject may form no unfitting introduction to a series of Physiological Essays. In the following remarks upon a Vital Principle, I make indeed little pretension to novelty, as the reflections of several of my friends have led them to adopt conclusions similar to my own; but I am inclined, on this account, to hope that what I advance will bear the test of candid examination.

In every example of rigorous philosophizing, the terms Principle, Law, Property, are used indifferently,

and are intended to express some general fact: thus it is equally correct to speak of the law, or the principle, or the property of gravitation; by each of which expressions one and the same general fact is alone implied, viz. that all bodies are attracted towards each other in the ratio of their masses, and with forces increasing, as the squares of their distances decrease. Such Laws, Principles, or Properties, are ascertained by a cautious induction of particular instances, whereby it is rendered evident, that the fact holds good under every conceivable variety of circumstances. Philosophical principles, which have been thus established, are in their nature incontrovertible, though they remain liable to be merged in expressions still more general. I know of no general fact in Physiology better calculated to illustrate the preceding observations, than that law of vision, which relates to our seeing such objects erect, as under ordinary circumstances are painted upon the retina reversed.

It may be remarked, as a corollary to the preceding statement, that, when all the phenomena of any science shall be contained under one expression, or in other words, when there shall be discovered in any science a law or principle, from which all its facts shall be synthetically deducible, that particular science will admit of no further improvement by the human intellect.

But the term Principle is sometimes employed with a looser meaning, in cases where rigorous laws have not been ascertained; thus, it is not uncommon to speak of a principle of electricity, or of magnetism: in

these and similar instances, the term seems merely to denote what is conjectured to be the common circumstance, characterizing the phenomena, to which it relates, and marks the want of those well-defined laws, of which it is the temporary substitute.

I believe that no other meaning can be attached to the word principle, whenever employed in relation to the facts of natural philosophy, than one of the two above explained: if I am right in this supposition, there will be no difficulty in deciding, in which of these two meanings the word is used in the expression, a vital principle. No one, I suspect, will venture to admit that all the phenomena of life are accurately understood; yet without this previous admission, they cannot be referred to a principle or law of the first kind, which I described. It is well known, indeed, that of the vital phenomena, which are best understood, there exist several classes, so thoroughly distinct in kind, as to render it extremely improbable, that a single law will ever be discovered comprehending the whole. If, again, it be granted, that in the instance before us, the word is used in its looser meaning, nothing, I conceive, is wanting to prove the trivial nature of all discussions respecting the existence of "a Principle of Life."

It will probably occur to the reader, in confirmation of what I have advanced, that the advocates of a vital principle have their strongest ground in those cases, the phenomena of which are more than usually ob-

scure; as when they detail the vital phenomena of the seed or egg, before the developement of the plant or animal begins: the truth, in this instance, is simply this; we are too slightly acquainted with the phenomena in question, to be able to reduce them to general laws.

But in the economy of grown plants and animals we certainly have obtained glimpses of those properties or principles, which are the legitimate objects of philosophical inquiry. It is indeed mortifying to confess, that in no one important instance is our knowledge of a vital law complete, and that it is even possible, that a more successful research may show, that all our present conclusions are erroneous; still it is interesting to trace any thing like an approximation to inductive principles in Physiology.

The law the most remarked, if not the most extensively prevalent, in living bodies, is, that certain textures, which are generally fibrous, when existing within a certain range of temperature, and under other conditions more or less accurately defined, will, if excited by certain agents, or as the mere result of their structure, suddenly contract themselves in one dimension, if not mechanically prevented, and that the preceding change naturally alternates with the relaxed state of the texture. To this principle, as it is found in the muscular fibre of living animals, Haller gave the name of Irritability; and the same term may be applied, till some reason be shown to the contrary, to

similar phenomena occurring in other textures, whether animal or vegetable.

A second property is that, by which solids and fluids are decomposed in living bodies: this process is unquestionably analogous to chemical conversion; but it seems trifling to give the general fact a name, whether organic affinity or any other, till the conditions, under which it occurs, be more exactly defined.

Sensibility and the other mental properties are satisfactorily traced in those animals only, which possess nervous systems; with certain conditions of these organs the mental properties seem closely connected; but on this head very little is known with certainty.

This slight notice of what seem to constitute our nearest approaches to philosophical laws of life, will serve to illustrate the yet backward state of Physiology, and at the same time to point out definite and legitimate subjects of inquiry. Bichat indeed was the first, who saw distinctly, that Physiology admitted of rigorous principles, yet he failed in his attempt to elucidate them. As I am not aware that any individual has pointed out the errors of Bichat's system of vital properties, I will state some objections to it, which have doubtless occurred to many.

"Nature," says Bichat, "has endowed each part of a plant with the faculty of being sensible to the impression of those fluids, with which its fibres are in contact, and with the power of reacting insensibly upon them, so as to promote their transmission. I call these two faculties, the one, the organic sensi-

bility, the other, the insensible organic contractility *." The reader infers from the next sentence, that the same properties prevail as universally in animals.

By this account, the organic sensibility is that property, in virtue of which the irritable fibre is excited by certain impressions in preference to others; but it is evident, on a moment's reflection, that the susceptibility to particular impressions is an essential element of the property of irritability, or, as Bichat terms it, contractility. If the existence of such a separate property were admissible in this case, by parity of reasoning, an organic sensibility should be attributed to matter in general; in virtue of which bodies would gravitate towards each other in the ratio of their masses, rather than in the ratio of any other quality.

Under the title again of insensible organic contractility, Bichat has thrown together properties so dissimilar, as that, on which the propulsion of a fluid through a tube depends, and that, by which its conversion into a new substance is effected: sometimes,

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* "La nature doua chaque portion de végétal de la faculté de sentir l'impression des fluides, avec lesquels les fibres sont en contact, et de réagir sur eux d'une manière insensible, pour en favoriser le cours. J'appelle ces deux facultés, l'une *sensibilité organique*, l'autre *contractilité organique insensible*."—Anatomie Générale, par Xav. Bichat, Tom. I. p. 12.

indeed, he seems wholly to lose sight of the existence of the latter property. After noticing such grave errors, it is scarcely worth while to point out the want of keeping displayed in his outline of the vital properties, on the occasion, when he enumerates as distinct principles three modifications of irritability, and clubs all the mental properties under the single term, animal sensibility. The striking boldness and general felicity of Bichat's speculations render it as expedient, that his errors should be pointed out, as they ensure the admission of his numerous correcter views.

In some of the preceding observations I have touched a chord, which has jarred somewhat in abler hands; I allude to the support, which the theory of materialism is supposed to derive from expressions similar to some made use of above. I have spoken of sensibility and the other mental properties being as seemingly connected with a nervous system, as irritability with a fibrous organ. I certainly am inclined to believe, though the evidence is in part analogical only, that no change whatever takes place in the functions of the mind, but in conjunction with a corresponding change in some part or the whole of the nervous system; and so far, physiologically speaking, the connexion between the mental properties and a peculiarly organized matter seems as strict, or nearly so, as that between irritability and another kind of matter. But the value of this argument in reference to materialism, I take to

be neutralised by the consideration, that mind and matter are logically distinct substances, and that there is nothing in their constant conjunction in our present condition, which renders their separate existence morally impossible, or interferes in the least with any probable evidence to that effect derived from other sources.

It would require more profound study, than I have given the subject, to enable me to entertain a positive opinion on another question, always drawn in on these occasions, whether, either the denial of a vital principle, or a physiological materialism, be inconsistent with revealed religion: but I confess to a plain straight forward thinker it would seem clear enough, that the several vital principles, which the inductive philosophy bids fair to establish, are as consistent with the tenor of the sacred writings, as the single vital principle of less precise signification; and with respect to a physiological materialism, not to mention the uncertainty of the argument, compared with the singular abstruseness and obscurity of the subject, I cannot help thinking, that even were the theory of materialism established, and I am far from thinking it to be so, it would not clash with the doctrines of revelation, which treat this point ambiguously, and in several places seem directly to favour the idea of an eternal connexion of the mental principle with a modified corporeal one.

It is much to be deprecated, that in this enlightened

age the discoveries of philosophy should be employed on the one hand unfairly in undermining religion, and on the other hand, through an equal ignorance of their real bearings, be rejected as hostile to its interests.

Experiments illustrating the Phenomena of Muscular Action.

MUSCULAR flesh, viewed as an object of physiological inquiry, is far from being a simple substance; but consists of blood-vessels, absorbents, and nerves, probably blended with some peculiar element, which appears to be inseparable from the other component parts of muscle.

Living muscle is observed to exist in two states; in one of which it is soft, and yields readily to pressure and extension; in the other it is hard, is with difficulty extended in the direction of its fibres, and, if no mechanical resistance interfere, it becomes shorter in this dimension. The former condition of a muscle is termed its state of relaxation; the latter, its state of action; it has been ascertained by Dr. Wilson Philip *, that some muscle will exhibit an alternation of these phenomena for as long a continuance, after its connexion with the brain and spinal marrow, by means of the nerves, has been interrupted, as when this connexion exists; whence it is inferred, that the irritability of muscle is not derived from either of the sources named.

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* Philosophical Transactions, Vol. CV. p. 81.

Previously to inquiry, we might conjecture either the state of action, or the state of relaxation (the terms no doubt being in this view objectionable), to be that, to which a muscle would revert in the absence of special impressions, or, in other words, to be that condition, which is the natural result of its structure; or we might suppose, with equal probability, a succession of these states to flow necessarily from the composition of a muscle: upon this general question I am afraid the following experiments throw little additional light, even if their details have any separate interest.

When a muscle of voluntary motion is exposed in a living body, and the joint, of which it is the flexor, be moderately bent, its fibres appear to lie in a right line: if the muscle be then excited to action, the brief contraction, which ensues, is unattended with any change in the direction of the fibres of the muscle: if the joint be bent to the utmost, the fibres of the muscle appear thrown into slight folds; and if the muscle is then excited, this appearance of folds is not lost. When a muscle is examined in its utmost degree of extension, or in its middle state, upon the limb of an animal very recently killed, the fibres appear straight; if the muscle be then divided, its portions retract, and its fibres describe waving lines. These experiments I have repeated several times on rabbits.

The general lateral swelling of a muscle during its action is as obvious as its hardening; and it is in the highest degree probable, that each fibre increases proportionately in breadth; but of this I cannot satisfy

myself by observation, without or with the microscope.

Various experiments have been made to determine, whether a muscle gain or lose in bulk during its contraction; all that I have met with have been exceptionable, on one ground or another; as, for instance, on the ground, that fluid might be retained in or leave the muscle or the limb at the moment the former contracts; or again, that there might co-exist some counteracting relaxation of an antagonist muscle: the objections, which I have mentioned, do not seem to me to apply to the following experiment.

A glass vessel was procured, having a narrow and open tube, three-tenths of an inch in diameter, at its upper part, and a large glass stopper removeable from its under surface; into this vessel, when inverted, and filled with coloured water, the ventricular part of the heart of a large dog was introduced, immediately after its excision from the animal, which had been previously destroyed by hanging; the vessel was then raised, with its tubular part uppermost, and the heart continued to contract vigorously for a sufficient length of time to enable me to be assured, that no elevation whatever or depression of the coloured fluid took place in the tube during the action of the heart. I have repeated this experiment several times. If it be true, as it is supposed, that the whole of the ventricular portion of the heart contracts at the same moment, any expulsion of fluid from the coronary vessels, during the action of the muscle, would not in

this instance interfere with the conclusion, which seems to me unavoidable, that the bulk of living muscular fibre remains the same in its different states.

With a view to ascertain whether the presence of blood in the vessels of a muscle be necessary for its action, the following experiments were made: The heart, together with a portion of the aorta, was removed out of the chest of a dog, immediately after its destruction by hanging; the tube of an injecting syringe was then fastened in the aorta, and warm water thrown into the coronary vessels, the heart still beating actively: while water was thus thrown in, in sufficient quantity to entirely wash the blood out of the heart, which became thickened, and had the appearance as of having been macerated for a few days, the contractions of the organ continued vigorous; but they ceased much sooner, after the injection was desisted from, than would have been the case, had this experiment not been made: on repeating the experiment, a similar result ensued; on a third trial, being willing to try to what extent the introduction of warm water could be carried, I injected considerably more than was sufficient to render the heart of a pale colour; the heart in this case swelled considerably, and after one or two beats became at once rigid, as if crimped. A similar experiment was made upon the voluntary muscles of the lower extremities of two dogs, with a like result; the tube being placed in the femoral artery, the muscles of each limb so treated became swollen and œdematous and pale, yet did not at first lose their

irritability, though they soon became hardened, as the heart became in the preceding case. It may be inferred from these details, that the presence of blood in the vessels of a muscle is not necessary to its action, but probably conduces only to the nutrition of the part, and the preservation of its temperature.

It seems probable that the habitual degree of contraction, which is remarked in certain muscles, and has been termed their tone, results from an act of volition: when all the branches of nerves passing to the lips of an ass are divided on either side of its face, the lips are observed to hang flaccid, disclosing the teeth of the animal: in a similar way, when in human beings one side of the face is paralysed, its expression is lost, the features of that side being partly drawn towards the opposite side, and partly dropping from the mere weight of the integuments. In order to ascertain, whether the muscles of voluntary motion have a tendency to assume any definite dimension, independently of the influence of the will, I exposed in the hind leg of a rabbit recently killed, those muscles which correspond with the tibialis anticus, and the extensors of the toes in human beings, and having fixed a piece of fine wire in two neighbouring tendons at the same level, as a measure, I divided one tendon when its muscle was extended to the utmost, and the other when its muscle was perfectly relaxed. I have repeated this experiment on the same muscles and on others, and on the portions of a single muscle, longitudinally separated; and in the majority of cases, the muscle, the tendon of which

is divided when on the stretch, is the most shortened of the two, and remains so. In a few instances I found no difference in the subsequent length of the muscles attend their division, made under these different circumstances. It may be mentioned, in connexion with the preceding facts, that the voluntary muscles become rigid at a certain period after death, without any reference to the position of the various joints of the body.

The spontaneous elongation of a muscle in some instances attends its relaxation, as in the heart removed from the body of an animal recently killed: a similar circumstance may be noticed in the voluntary muscles at the same period. When these are exposed a few minutes after death, rapid contractions soon begin to play over them: these appear to commence some short time after the exposure of the muscle. If when these are present the muscle be divided, after the first sudden retraction of either portion, the brief contractions continue as before; subsequently to each of which the portion of muscle distinctly and fully regains its previous length.

From several of the preceding observations, viewed in connexion with others more generally known, I should infer that the relaxed state is that, which is natural to the voluntary muscles, and that their contraction results from a casual extraneous impression; an inference, I believe, in nowise at variance with that generally received. But I am inclined to adopt a different conclusion relatively to the heart, and to

suppose that the alternation of action and relaxation in this muscular viscus results immediately from its structure. This at any rate I take to be the just conclusion deducible from the facts at present before us, and that which would be logically secure, were we certain that no additional facts bearing upon this point would be brought to light.

The facts, to which I allude, are the following: when the heart of one of those animals, which are the usual subject of physiological experiment, is removed from the carcase immediately after death, it seems to contract and dilate for a little time with full vigour; whence we may infer that neither the brain nor spinal chord furnish the stimulus to each contraction, as occurs in the voluntary muscles. The true explanation may now be perceived of the beating against the side of the chest, which is synchronous with the diastole of the aorta: the heart contracting upon the table, is observed to throw up its apex at each systole of the ventricles; the superior weight of the base of the heart in this case gives the part that fixedness, which in the body it derives from the vessels, which are continuous with it. When the inner surface of the heart is washed out carefully, the motion of the heart continues unimpaired; nor, as I have before mentioned, does even the washing out the blood contained in the coronary vessels immediately affect the action of the heart.

When the auricles again are cut off, the alternate contractions persist: if the auricles be cut off with a

small portion of the ventricles, so as that they preserve their natural form and expansion, they may be seen contracting fairly and equably as before, keeping exact time with the separated apex of the heart; and when, as is usually the case, the contraction of the ventricles declines before that of the auricles, I have noticed the separated ventricles still keeping time with the auricle, and at first accurately intermitting the beat, which should follow each second contraction of the auricles: the latter circumstances may have been casual.

Finally, if such a longitudinal section be made, as to divide the septum and either auricle and ventricle of the heart, the separate portions continue to act regularly for a short space of time.

Essays of Reil on the Structure of the Cerebellum.

The observations of Reil on the structure of the brain, as shown after its induration in alkohol, are nearly unknown in this country. As they possess the highest interest in every point of view, I shall venture to offer the whole of them to the public in an English translation, together with accurate copies of the engravings which accompany the original essays. With the assistance of these engravings the reader may easily repeat, as I have done, the dissections, which Reil describes.

At present I publish the matter of four essays only, which treat of the cerebellum. These are to be found in the 8th and 9th volumes of the Archiven für die Physiologie of Reil and Autenrieth, which correspond with the years 1807 and 1808 *.

In translating these Essays, I have taken the liberty of occasionally condensing the descriptive details given by the celebrated author, where, by so doing, I might diminish their intricacy and obscurity, as well as that of wholly omitting passages consisting of reflections of no physiological value.

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* It appears, upon his own statement, that Reil commenced this series of inquiries about the year 1795.

Inquiries respecting the Structure of the human Cerebellum, by Professor Reil. Archiven für die Physiologie, achter band. p. 1—58.

I.

Description of the external surface of the Cerebellum.

The cerebellum is not composed of elementary portions essentially different, but is one homogeneous organ; externally it consists of laminæ of medullary matter [mark blätten], which are enveloped in cortical substance [rinde], and are attached to medullary stems [markstämme]. The medullary stems, on the one hand, branch into lobes [läppen] and lobules [läppchen], the subdivision ending with the laminæ; on the other, they unite to form central medullary nuclei [markkerne]. From the latter three processes are given off on either side, comprising two to the cerebrum, the pillars of the Vieussenian valve, two to the medulla oblongata, the corpora restiformia, and a third pair situated between the two former, passing to the annular protuberance.

The cerebellum lies below the posterior lobe of the cerebrum, in a cavity, which is enclosed below and behind by the sphænoid and occipital bones, laterally by the petrous portions of either temporal bone, and

above by a process of the dura mater. The cerebellum measures transversely, at its greatest breadth, from three inches and ten lines, to four inches; longitudinally, above, and in the centre, twenty lines: either lateral portion is about two inches long, and about sixteen lines thick at its middle. The lateral parts are called hemispheres [seitentheile, hämisphärien]. The central part is called the general commissure [mittelstück, nath, total-commissur, wurm], and consists of two portions, the superior and inferior vermiform processes. The superior of these terminates at the commissure of the upper and posterior lobes. When viewed from above, the two hemispheres are externally circular; internally, where they approach to join the general commissure, their margin is deeply notched both before and behind. Thus two fissures [ausschnitte] are formed, one looking forwards towards the cerebrum, and receiving the tubercula quadrigemina, termed the semilunar fissure [vordere, halbmondförmige ausschnitt]; the other backwards, which receives the falx cerebelli, termed the purse-like fissure [hintere, beutelförmige ausschnitt], from its narrowness at first, and subsequent enlargement: in the latter is the line, at which the superior and inferior vermiform processes meet.

The upper surface of the cerebellum is not horizontal, but raised a little anteriorly towards the tubercula quadrigemina, and depressed laterally and behind. The under surface is somewhat hemispherical, having along its middle a deep and broad depression, the

valley [thal], extending from before backward, in which the medulla oblongata is lodged, as well as the inferior vermiform process: the latter is separated from the hemispheres on either side by a furrow. The valley is broadest at its middle, where the pyramid is placed: behind this point it is contracted by the inner extremities of the lower and posterior lobes, and before by the almond-like lobes.

I employ the term horizontal or lateral fissures [seitliche horizontal-furche], to designate those depressions, which extend transversely across the fore part of the cerebellum, and contain the processes passing to the annular protuberance. These fissures are continuous with the intervals between the upper and under posterior lobes, which extend as far as the purse-like fissure: thus a deep furrow may be traced all round each hemisphere, dividing the cerebellum into an upper and an under portion.

Either surface of the cerebellum is composed of that laminated structure, in which the medullary processes rising directly from the nuclei ultimately terminate: the laminæ are divided by furrows of greater or less depth, which are more or less parallel to each other, and constitute each a segment of a circle, the convexity of which is turned backwards, and the horns forward and towards the horizontal fissure. The deeper furrows pass down to the medullary nuclei, and form the boundaries of lobes: the shallower furrows, which are not continued over the entire surface of a hemisphere, form the boundaries of lobules. This structure is best

understood from the vertical section of an hemisphere.

In some places, particularly in the deep furrows between the lobes, and in the shallower furrows of the lower and posterior lobe, several laminæ are sometimes found united, so as to form an irregular band of short extent [ein schwanz]; sometimes an abrupt and tongue-like projection [eine zunge] arises from the bottom of a furrow, consisting of a few laminæ, not directly connected with any neighbouring lobe or lobule.

Each hemisphere has five lobes, of which two compose the upper, three the under surface: these are, first, the square, or anterior and upper lobe [vierseitigen, vörderen oberen lappen], which is seen on either side of the superior vermiform process, forming the fore part of the upper surface of the cerebellum. This lobe extends from the tubercula quadrigemina to the commissure of the upper and posterior lobe, and is united to the vertical process of the general commissure, and to all those portions of the horizontal process, which are given off above the single commissure. Secondly, the posterior and upper lobe [hinteren oberen lappen]; which forms the upper and posterior surface of the cerebellum, extending as far as its margin. The limits of this lobe are easily defined by tracing its union with its fellow, by means of the single commissure, and following from thence the furrow, which is continued outwards to the horizontal fissure betwixt this lobe and the next. Thirdly, the

lower and posterior lobe [hinteren unteren Lappen]; this is united to its fellow by the short and exposed commissure, and by the long and hidden commissure; and sometimes it adheres to the posterior surface of the pyramid. The fourth, or slender lobe [zarten Lappen], is joined to its fellow, sometimes by the last laminæ of the long and hidden commissure, but for the most part by the laminæ of the posterior part of the pyramid. The fifth, or biventral lobe [zweibaüchigen lappen] lies between the slender lobe and the almond-like lobe. The latter is pressed inwards towards the valley, while the biventral lobe is the last, which conforms to the circular arrangement of the parts upon the under surface of the cerebellum. This is distinguishable by its wedge-like form, by the direction of its furrows, which are nearly parallel with the medulla oblongata, and by its union with its fellow, through the anterior laminæ of the pyramid, in the valley.

If we examine the contents of the valley, beginning at the upper part of the purse-like fissure, we find that they occur in the following order: above is placed the single commissure [einfache quer commissur], by which the upper and posterior lobes of either hemisphere are connected; immediately below this the short and exposed commissure [kurzen und sichtbaren commissur], by which the under and posterior lobes are united; below this again the long and hidden commissure [langen verdeckten commissur], by which the under and posterior, as well as the slender lobes

are joined together; next the pyramid [pyramide] in the broadest part of the valley, a tongue-shaped body, somewhat flattened, and marked with transverse furrows on either side: then the spigot [zapfen], a body smaller than the pyramid, towards which its base is turned, and the nodule [knotchen], the last and least.

On either side of the forepart of the valley, between the concave surfaces of the biventral lobes on the outside, and the spigot and nodule on the inside, and in contact with the posterior velum, lie the almond-like lobes; these are covered in part by the medulla oblongata: it is equally difficult to class these lobes as portions of the hemispheres, or as parts belonging to the valley.

The medullary matter of the cerebellum exists in greatest volume in either hemisphere, constituting the medullary nucleus of each, whence the primary processes arise, which are expanded in an arborescent form to constitute the laminated circumference. Anteriorly the nuclei advance towards the medulla oblongata, enclosing laterally the fourth ventricle; each then divides into three processes or peduncles [arme, schenkel], of which one pair passes forwards to the tubercula quadrigemina, termed the peduncles of these bodies [arme zu den vierhugeln]; a second pair to the medulla oblongata, being its peduncles [arme zum rückenmark]; the third pair passes under the annular protuberance, constituting again its peduncles [arme zur brucke].

Between the two superior peduncles, which pass to

the tubercula quadrigemina, a medullary membrane is expanded, which adheres to the inner edge of either peduncle—this I call the anterior medullary velum [vördere marksegel]; over against it is situated the posterior medullary velum [hintere marksegel], which has a middle portion attached to the nodule, and two free semilunar portions attached to the flocks of either side.

The flocks [flocken] are a pair of additional processes found in the human cerebellum, and not in that of animals, which emerge obliquely from between the almond-like processes, the medulla oblongata, and the peduncles of the annular protuberance, and are connected by the posterior medullary velum; they seem as if the germs of two other lobes, and the posterior velum their intended commissure, which nature has not completed for want of room.

Having thus described the external appearance of the cerebellum, I will detail the method, in which the organ must be prepared, previously to the display of its internal structure.

The cerebellum of a male should be selected, and of one, who may have died in early manhood of some chronic disease; it should be in as fresh a state as possible; the brains of those, who have died of typhus, lose their consistence too soon for this purpose, and where inflammation of the brain has existed, the membranes are not easily separable. The cerebellum may be detached by dividing the crura cerebri above, and the medulla oblongata below; it should then be placed

in a basin under water, and the membranes removed with the forceps: the membranes are prevented from drying, and the blood exudes more freely, when the part is thus immersed in water. The denuded cerebellum is now to be placed in a vessel, and to be twice washed by the affusion of brandy, which may be suffered to remain on it some minutes; afterwards alkohol is to be substituted, in which it should stand twelve hours; when in this way, the surface appears somewhat hardened, the membrane is to be removed from the deeper furrows, in order that the spirit may every where penetrate the mass; spirit is then again to be poured over the preparation, which may stand a day or two: finally, the alkohol is to be renewed, and the vessel closed and set by for two or three months, till the part has acquired a greyish colour, and is thoroughly hardened. It is right, during this time, to turn the preparation occasionally, and to contrive that every surface is freely bathed in the spirit.

Explanation of the First Plate.

Fig. I.

This figure represents the upper surface of the Cerebellum.

a. a. The Crura Cerebri divided near the annular protuberance.

b. The Pineal Gland.

c. c. The transverse bands of medullary matter lying below the Pineal Gland.

d. The Tubercula Quadrigemina.

e. e. The fourth pair of Nerves.

e. h. e. The Anterior or Semilunar Fissure of the Cerebellum, enclosing the peduncles of the annular protuberance and the tubercula quadrigemina; the margin of the fissure is parallel to the course of the fourth pair of nerves, which bodies it additionally contains.

f. f. The Superior Vermiform Process of the Cerebellum, by means of which the square lobes are united. This part is distinguished from the hemispheres by a shallow furrow on either side, and by the incurvation of its laminæ forwards, whereas those of the square lobe are inclined in a contrary direction.

m. l. i. e.—m. l. i. e. The two Hemispheres which are united centrally by the general commissure.

g. g. The Anterior or Square Lobes of the Cerebellum, which are separated into lobules by shallow furrows.

h. The Central Lobe in the semilunar fissure.

i. i. The deep furrow which separates the square lobe on either side from the upper and posterior lobe, and runs outwards to join the horizontal fissure, while posteriorly it terminates in the purse-like fissure.

k. k. The Upper and Posterior Lobe.

l. l. l. l. The deep furrow by which the upper and posterior is separated from the lower and posterior lobe.

m. m. The inner extremities of the under and

posterior lobes, which contract the entrance of the purse-like fissure.

i. i. l. l. The Posterior or Purse-like Fissure.

Fig. II.

The Cerebellum, as seen from before; the annular protuberance, its peduncles, and the lateral parts of the upper and lower lobes, which reach the horizontal fissure, are seen.

a. a. The Crura Cerebri divided.

b. The deep hollow between these and the anterior margin of the annular protuberance, out of which the third pair of nerves emerges.

c. The Annular Protuberance.

d. The Medulla Oblongata divided.

e. e. The fifth pair of Nerves.

f. f. The Peduncles of the Annular Protuberance lying in the horizontal fissure.

e. f. k. g.—e. f. k. g. The Horizontal Fissure on either side, which contains the peduncles of the annular protuberance, the latter being overlapped by the outer extremities of the lobes. This fissure is continuous with that deep furrow, by which the two posterior lobes, and thus the upper and under surfaces of the Cerebellum, are separated from each other.

h. i. f.—h. i. f. The terminations of the square lobes in the horizontal fissures.

h. g. k.—h. g. k. The terminations of the upper and posterior lobes in the same fissure.

k. g. l.—k. g. l. The Extremities of the lower and posterior lobes lying over against the former.

l. m. n.—l. m. n. The Lobules of the biventral Lobes, which are in contact with the flocks, and in the horizontal fissure lie overagainst the square lobes.

n. n. The flocks on either side, the globular ends of which project in the interval between the fifth pair of nerves, the lobules of the biventral lobe, and the square lobe.

The Second Plate.

Fig. I.

In this figure the under surface of the Cerebellum is represented: the annular protuberance, its peduncles prolonged into the horizontal fissures, the inferior surface of the hemispheres, and the inferior vermiform process in the valley, the component parts of the latter being somewhat separated, are seen.

a. a. The Crura Cerebri divided.

b. b. The third pair of Nerves, fasciculated at its origin, which springs out of the funnel-like hole.

c. The Annular Protuberance.

d. d. The Peduncles of the Annular Protuberance, which lie between the two surfaces of the Cerebellum in each horizontal fissure, pass forward above the flocks, and unite to form the annular protuberance.

e. e. The fifth pair of Nerves, in their structure fasciculated.

f. f. The sixth pair of Nerves, also fasciculated.

g. g. The Portio Dura of the seventh pair, on either side; which emerges from a hollow, enclosed before by the annular protuberance, internally by the corpus olivare, and externally by the peduncles of the medulla oblongata.

h. h. The Portio Mollis of the seventh pair, on either side.

i. The Medulla Oblongata divided; at the fore and under part of this body is a triangular hole, bounded before by the posterior margin of the Annular Protuberance, and laterally and behind by the pyramidal bodies; into this hole a branch of the basilar artery plunges.

k. k. The outer and projecting extremity of the lobules of the Square Lobe on either side: these are opposed to the outer extremities of the inferior lobes of the Cerebellum, which form the under margin of the horizontal fissure.

l. l. The Flocks; their white stems rising from the almond-like lobes, and their grey, foliated, and globular ends are seen. A few laminated processes are attached to each stem, particularly at its posterior margin, which overlap the peduncles of the annular protuberance.

m. m. The upper side of the Fourth Ventricle.

n. The Nodule.

o. The Spigot.

p. The Pyramid.

q. The Short and Exposed Commissure in the posterior fissure.

r. The Posterior or Purse-like Fissure.

s. s. The Almond-like Lobes.

t. t. The Biventral Lobes, which extend wedge-like towards the Valley (as is best seen on the left side), and are united by their apices to the Pyramid.

u. u. The Slender Lobes.

v. v. The Under and Posterior Lobes.

Fig. II.

The Cerebellum viewed from behind.

a. a. The Posterior Margin of the Annular Protuberance.

b. The Medulla Oblongata divided transversely.

c. c. The Almond-like Lobes.

d. The Pyramid.

e. The Short and Exposed Commissure in the posterior fissure.

f. The Single Commissure of the upper and posterior lobes. It resembles in structure the short commissure, and might be accounted the first transverse lamina of the latter: it is placed intermediately between the two vermiform processes *.

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* Reil appears at one time to class the single commissure with the parts of the inferior vermiform process, at

g. The posterior part of the Superior Vermiform Process, extending to the single commissure.

h. h. The Apex of the Biventral Lobe.

i. i. The Slender Lobes.

k. k. The Under and Posterior Lobes.

l. l. The Upper and Posterior Lobes.

m. m. The inner extremities of the posterior lobules of the Square Lobe, which are continuous with the superior vermiform process.

II.

Of the Vermiform Processes, or General Commissure, by which the two Hemispheres of the Cerebellum are united.

Under this title I include all those parts, which are divided by a vertical section carried through the median plane of the Cerebellum; viz. at the upper and fore part, the anterior medullary velum, the superior vermiform process ending at the single commissure, the short and exposed commissure, the long and concealed commissure, the pyramid, the spigot, and the nodule, which occur in the above succession.

The following sketch may serve to give a general

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another, to consider it a body separate from and intermediate between either vermiform process.

idea of the double arrangement of parts, which is met with in the structure of the cerebellum: externally there would seem to be an apparatus, partly composed of vessels and cortical substance, in part again of the medullary matter immediately subjacent, which may be followed in its curvilinear course to the annular protuberance: this apparatus may be compared to the plates of a voltaic pile; the cortical and medullary laminæ, which compose it, are merely in apposition, and may easily be drawn asunder, leaving smooth surfaces. Internally, there would seem to be an apparatus, more or less analogous to the conductors of a voltaic pile; this internal part is continuous above with the tubercula quadrigemina, by means of the peduncles, which pass to these eminences; and below with the medulla oblongata, by the peduncles frequently termed corpora restiformia.

This general plan seems to be followed on all occasions; in the cerebellum of the bird, it is adopted in its simplest form: in this instance there is one erect pyramidal process, with double laminæ before and behind, in the medullary nucleus of which, there exists a narrow conical hole, directed outwards, giving passage to the peduncles. The cerebellum of the bird represents indeed a vermiform process alone, and wants the lateral parts, which are superadded in animals more nearly allied to human beings in their anatomical construction, possessing in their place little germs or shoots scarcely discernible.

The successive additions, which may be traced to this simple form of a cerebellum, consist but of parts of similar structure with the elementary part; sometimes these cohere with the primitive portion, by continuity of their medullary substance alone, being otherwise separate and distinct; in other cases, the separation is slighter, and the new parts are continuous with the old, both through their medullary and their cortical substance; the former may be termed off-sets (ansätze), the latter wings (flügeln) of the vermiform process. Among the lower animals, there are but few and simple off-sets; higher in the scale, these become more numerous; the vermiform process extends itself laterally and receives wings, and in proportion as the wings are developed, the off-sets diminish. The first improvement in the cerebellum takes place at its anterior and upper surface; while on its under surface the parts remain contracted and shrunken. The vermiform processes predominate even in quadrupeds, in length, breadth, and depth; the fore part only of the cerebellum possesses distinct wings; laterally and behind, there are only off-sets. In proportion as the fabrick improves, the off-sets are changed into wings, till at length in human beings the hemispheres are completed; and with the exception of the flocks, the off-sets have wholly disappeared. All the parts are now brought together in compact order: the vermiform processes, with their wings, constitute one whole, between the parts of which the freest communication

seems to exist, which the employment of off-sets would interrupt.

In the brain of the hare there is little more than a vermiform process: there are but few wings, and these slight and short: the lateral off-sets are small. In the brain of the sheep the central lobe is large, firm, and broad, but has neither wings nor off-sets: the anterior velum is somewhat depressed upon the fourth ventricle. The next lobe in order is broad, of some length and depth, but has laterally short projections, not equal in their breadth to half the length of the vermiform process; these, however, may be viewed as wings. In the third lobe the organ is contracted, and has longer and larger wings; there follow, upon the under surface, a pyramid, spigot, and nodule, which have no wings, but a large bundle of lateral off-sets; between the wings and off-sets the peduncles of the annular protuberance emerge, and mark the place of the horizontal fissure. The whole cerebellum has a globular form, which results from the projection of the vermiform processes. The latter stand more or less vertically over the medulla oblongata, and have an anterior and a posterior surface, which correspond with the superior and inferior surfaces of the same parts in the human brain. The lateral off-sets in the higher animals are more and more driven from the fore to the back part of the cerebellum, until at length, in the human brain, they are exchanged for the lobes of the inferior surface, which unite with the inferior vermi-

form process. The whole cerebellum seems indeed pressed backwards, as its parts become more complex; so that the central lobe continually emerges more and more from between the peduncles of the tubercula quadrigemina, and in the human brain lies fairly behind these bodies, the common anterior stem being directed upwards, and the posterior horizontally. In the brain of the ox the central lobe is large, and without wings; the remaining lobes of the anterior surface are of inconsiderable dimensions: on the posterior surface, the pyramid, spigot, and nodule are barely separable; they are without wings, and have scarcely off-sets. Lastly, in the brain of the horse the central lobe is large, and without wings, but of less size than in the ox, and more compressed from above downwards. The next lobes of the vermiform process have anteriorly larger and longer wings, which are bent forwards, contracted in their middle, and at their ends have a club-like thickening. The upper and posterior lobe is distinct; but the under and posterior, the slender, the biventral, and almond-like lobes are wanting, and in their stead a large bundle of irregular off-sets is found on either side of the pyramid, the spigot, and the nodule.

Thus the enlargement of the cerebellum proceeds from the central primary portion; to which new processes, as wings or off-sets, are continually added, in proportion as the scale of its improvement rises. In quadrupeds, and even in the human brain, traces of

the simplest type of a cerebellum are to be seen in the central lobe, illustrating further the principle, on which its improvement proceeds. The furrow between this lobe and the lateral processes connected with it, is so deep, as to leave it doubtful whether the latter are properly wings or off-sets.

In the human brain the wings form the principal part of the cerebellum, viz. the hemispheres. On the upper surface these are immediately prolonged from the vermiform process; on the under surface they seem incomplete, being separated by a deep furrow from the inferior vermiform process on either side. It is remarkable that the human cerebellum, the most complex in its structure of any, should yet exhibit a resemblance of the clearest kind to the primitive and elementary form. When the human cerebellum is placed with its usually horizontal axis in a vertical direction, it may be rigorously compared with the cerebellum of birds: what in the latter case is a single lamina, is here subdivided, and has become arborescent; in the one case single leaves, in the other, lobes, lobules, and finally leaves, are raised around the nucleus, forming a dense investment to it, from under which the peduncles project on each side, like the fin-like feet from under the shell of the turtle.

In proportion as the lateral parts increase in the shape of off-sets or wings, the vermiform processes become smaller, as if compressed towards the centre. This circumstance is most apparent in the human brain: the vermiform processes are there compara-

tively diminutive in every dimension, in length, breadth, and depth: before them spring out the horns of the semilunar fissure, behind them the projecting margin of the purse-like fissure: within the latter, and at the place of the spigot and nodule, the inferior vermiform process is scarcely a few lines in breadth. In animals the vermiform processes overtop the lateral portions; in man the upper surface of the general commissure is only on a level with the hemispheres, while below it is contracted and shrunken to the bottom of the valley. This compression of the general commissure on all sides in the human brain, accounts for the difference observable in its structure as compared with that of the hemispheres; a difference which is not found in the brains of quadrupeds. In its texture this part in the human brain is softer, and its membrane firmer and more vascular than is the case in the hemispheres. The medullary matter is here again in thinner layers than in the hemispheres: thinly spread out in the anterior velum, it forms a thicker mass at the meeting of the vertical and horizontal process, where the nucleus of the general commissure begins: in the former process it exists in greater quantity than in the latter, and finally it forms an extremely thin layer in the posterior velum In the anterior fissure the general commissure has its greatest breadth, becoming narrower as it passes towards the purse-like fissure: in the single commissure, where it has shrunk to a single lamina, and in the short commissure, it continues still narrow; it becomes

broader again at the pyramid, and finally tapers to a point in the spigot and nodule. On either side of the superior vermiform process there are furrows of greater or less depth, at which the laminæ are thinner, and indented, and their direction altered; so that whereas the convex margin of the laminæ of the hemispheres is directed backwards, that of the laminæ of the superior vermiform process looks forward. In these furrows, by which the lateral limits of the superior vermiform process are defined, blood-vessels are lodged: these furrows are continued along the valley, where they become deeper.

Looking generally at the vermiform processes, we observe that they are composed of corresponding portions on either side of the median plane, that there is no material difference in the structure of the upper and under portions, and thus that the whole is one homogeneous organ. We may observe further, that whereas in birds these parts constitute the whole of the cerebellum, and in quadrupeds the principal portion; in human beings, where their relative bulk is trifling, compared with that of the hemispheres, they are, on the one hand, parts of the same composition and nature with the latter, and on the other may be considered as the general commissure, by which the lateral portions are intimately united.

Explanation of the Third Plate.

Fig. I.

The first figure of this plate represents the appearance on the left side, resulting from a vertical division of the cerebellum in the median plane: it comprehends a section of the superior vermiform process, by means of which the square lobes are united, of the single commissure of the upper and posterior lobes, of the short and exposed, and of the long and hidden commissure, of the pyramid, the spigot, and the nodule, and of the fourth ventricle; this view is extremely instructive, and the care with which it is executed, will be evident on comparing it with Vicq. d'Azyr, Tab. XXV. Fig. 1, and Tab. XXIX. Fig. 3.

For this view the part is prepared in the following manner: when the cerebellum has been carefully stripped of its membranes, especially in the neighbourhood of the vermiform processes, it is to be placed in alkohol, its upper side downwards, the hemispheres resting upon two tolerably broad supports, which should lie parallel with the vermiform processes; the medulla oblongata is then to be somewhat raised, and the parts in the valley readjusted, if they have been displaced in the abstraction of the mem-

brane. When the Cerebellum is sufficiently hardened, a section is to be thus made: the medulla oblongata is to be cut through with a common scalpel in the direction of the basilar furrow, together with the tubercula quadrigemina; the knife will have passed through the aqueduct of Sylvius: the vermiform processes are now completely exposed. The division of these parts should be accomplished at one stroke; for which object, a long and very thin brain-knife, about an inch broad, and with a rounded end, is best adapted: to ensure perfect precision, a right line should be drawn on the surface of a table, a thread should then be placed carefully along the middle of the vermiform process, and the part so inverted, as that the thread should coincide with the line drawn on the table; the annular protuberance should lie towards the dissector; the knife should then be placed in the middle of the purse-like fissure, and drawn at once through the middle of the cerebellum, dividing it into two similar portions.

a. The Medulla Oblongata and the Annular Protuberance divided.

b. The Aqueduct of Sylvius, which leads under the tubercula quadrigemina to the fourth ventricle, divided.

c. The Tubercula Quadrigemina, covering the aqueduct of Sylvius, cut through in the median plane. In this section there is seen near the posterior margin of the tubercula quadrigemina, where the anterior medullary velum is attached, and immediately over the aqueduct, a hole of the size of a poppy seed, into

which on the left side a minute canal opened, through which a blood-vessel had probably passed. The section of the anterior velum follows; its passage from the posterior margin of the tubercula quadrigemina to the nucleus of the vermiform processes is seen; this process is medullary below, where it looks upon the fourth ventricle; above, it is composed of cortical matter, and marked with transverse furrows; in some brains it is smooth and medullary above. For the distance of a third of its passage from the tubercula quadrigemina, the posterior velum is inclined downwards, and forms the posterior part of the aqueduct: it then passes backwards, towards the vertical process of the general commissure, and unites itself at an acute angle with the middle portion of the posterior velum, so as with this to form the tent-like roof of the fourth ventricle.

d. The Central Lobe, the first branch of the vertical process, which lies in the semilunar fissure, with its anterior surface opposed to the anterior velum, and is divided into three branches.

e. The Vertical Process in its full dimensions, showing its manner of division. The entire section consists of the vertical and the horizontal process, which seem to allow of very trifling variations. The vertical process has always more medulla than the horizontal process; it is the medium of connexion between the portions of the square lobes, as far backward as their fourth lobules; hence it results that a deep furrow is found behind these fourth lobules, passing into the general commissure, and extending as far as its me-

dullary nucleus, and the roof of the fourth ventricle, and marking the interval between the vertical and horizontal processes. The vertical process has seven, and with the central lobe eight distinct branches, which serve as commissures to the anterior lobules of the square lobe; it has seldom more branches, sometimes the branch concealed behind the central lobe is wanting.

g. f. h. i. k. l. The Horizontal Process, the larger of the two, from which all the remaining branches are derived, which belong to the general commissure: in birds the vertical process is the larger, the horizontal process having scarcely germinated. In the brain of the hare the posterior branch is the larger, standing vertically, but with its point bent forward over the anterior branch. In the sheep, the nodule, the spigot, and the pyramid are very distinct on the posterior surface of the horizontal process: above, the germ of the commissure for the slender and posterior lobes, and upon the fore part, the short projections of the lobules of the square lobe are seen. The same points are noticed in the brain of the ox; the nucleus in this case is triangular. In the brain of the horse, the nodule, spigot, and pyramid are complete; at the summit of its cerebellum there are large processes for the slender and posterior lobes; on the other hand, the germs upon the fore part of the posterior lobules of the square lobe, are short and small: the anterior process has six branches, which do not, as in the human brain, arise from a common root, but all spring sepa-

rately and at an equal depth from the nucleus, which is large and round.

f. The Single Commissure of the Upper and Posterior Lobes; by means of which these lobes are easily distinguishable from those adjacent: this transverse band is the land-mark between the superior vermiform process, which lies above it, and the inferior vermiform process, which comprehends all the parts below: it is flat, and narrow, in the middle medullary, externally covered with a thin layer of cortical substance, without branches, and, it would seem, the direct continuation of the horizontal process. Sometimes, as in this case, the single commissure is not furrowed, and has a smooth surface on either side, which above is about three lines broad, below, somewhat more; sometimes, again, both surfaces, the upper and the under, are transversely furrowed, as is the case with the anterior velum; occasionally a lobule of the square lobe is found attached to this commissure.

g. Before and above the last described commissure, the horizontal process has the fewest branches; there being but four, and sometimes only three of these, which are small and deeply seated behind the vertical process, besides a fifth and more prominent branch, which again is subdivided into three; all these branches belong still to the square lobes, and complete the union of their posterior lobules.

h. The branch of the Horizontal Process, which lies immediately below the single commissure connecting the upper and posterior lobes. The laminæ of this

branch, which are visible in the purse-like fissure, and are five in number in this case, form the short and exposed commissure, by which the under and posterior lobes are specially united; these laminæ vary in number from four to seven; the laminæ of the under surface of this branch, which rest upon the upper surface of the pyramid, form the long and hidden commissure, by which the inferior lobules of the under and posterior lobe, and the lobules of the slender lobe are united: these commissural bands vary in number from seven to twelve; they may be exposed by depressing the pyramid.

i. The next branch is the Pyramid, the apex of which appears immediately below the short commissure. The upper surface of the pyramid is opposed to the long commissure; the under, to the spigot. It is here divided into three large twigs; by means of two or more cross bands it is connected to the biventral lobes, on either side.

k. The Spigot, divided into three minor branches, each of which is again subdivided: sometimes this part is smaller, and consists but of two branches; it is connected on either side with the almond-like lobes, by means of a transversely furrowed lamina, which gives attachment to the posterior medullary velum, being placed immediately behind the swallow's nest.

l. The Nodule is the last branch of the horizontal process, and the termination of the inferior vermiform process; at its outer margin it is slightly furrowed, in its centre divided into laminæ. The anterior surface

of the nodule is medullary, and is attached to the central part of the posterior velum, serving with the latter as commissure to its own lateral portions, and to the flocks.

m. The profile of the fourth ventricle, as it appears upon an accurate division in the median plane; its form is triangular, and what may be called its roof, tent-like. The medulla oblongata forms its floor; one sloping side is formed by the anterior, another, by the posterior velum. The nodule is in this case somewhat bent downwards, and on this account the ventricle appears larger than usual, where the medullary vela meet; laterally the ventricle is more roomy, from the inclination of the lateral portions of the posterior velum upwards.

Fig. II.

The central lobe of the Cerebellum, deprived of its cortical substance. In place of continued furrows its surface exhibits unconnected grooves, and the ridges between these grooves resemble in their manner of branching the nervous filaments of the eighth pair*.

a. a. The short wings of the central lobe.

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* Reil Exercitationum Anatomicarum, Fasc. 1. de Structurâ Nervorum. Halæ. 1796. Tab. I. Fig. 2, 3, 4, and 5.

c. The middle portion, or that belonging to the superior vermiform process, which is of remarkable bulk in proportion to the wings.

b. b. The places where the wings and central portion are connected. This is not effected in the manner of an off-set, for there is a true and entire communication; only the connecting isthmus is contracted, and without grooves or ridges.

Fig. III.

The central lobe from another brain, covered with its cineritious substance; on this account, instead of grooves and ridges, it has the usual linear furrows.

a. a. The two wings, in connexion with the middle portion.

c. The middle portion.

b. b. The Isthmus between the wings and central portion.

III.

Of the Posterior Medullary Velum in the Cerebellum.

So indifferently has Tarin * described the posterior velum, and he has represented it even worse, that it is

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* Tarin adversaria Anatomica. Parisiis, 1750. Tab. II. fig. 2. *n. n.* p. 8.

not wonderful that Haller* should have misunderstood his statement, and have expressed himself unsatisfied of the existence of this part: and although Malacarne† has since, and indeed with the merit of an original observer, given a complete account of the posterior velum, yet the existence of this part is not yet generally acknowledged. Some anatomists mention it always as a part of dubious existence; others quote previous descriptions of it, not having themselves seen it; nevertheless it is a part as clear and distinct as the anterior velum.

Tarin and Malacarne in describing the posterior velum employ the word flaps [klappen], and speak of two, one on either side. Malacarne uses the expression semilunar flaps, Tarin that of semicircular, inferior, and posterior flaps; but to speak more accurately, there exists a third or middle portion, which lies before the nodule, the three together forming one continuous whole: this whole I name the posterior medullary velum, and divide it into a middle slenderer and attached portion, and two lateral free and semilunar portions.

The two lateral portions of the posterior velum are perfectly alike: their substance is medullary, their structure membraniform, their epithelion that common to the fourth ventricle, their form semilunar, their

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* Haller. Elem. Physiologiæ, Tom. VI. p. 76.

† Malacarne. Nuova Esposizione della vera Struttura del Cerveletto umano. Torino, 1776.

convex margin adherent, their concave edge turned forward and unattached, so that it is easy to introduce a probe above either of them, and to carry it round its convex attached circumference. They have two extremities, an inner and an outer, at which the two margins join. Their outer extremities are attached to the internal sharp margin of the flocks, and pass along these bodies to the point, at which their first laminæ are given off. From either outer extremity the fixed and convex margin may be traced backwards to the root of the almond-like lobes; during the first half of this passage being adherent to the corpora restiformia: thence the convex margin passes under the peduncles of the tubercula quadrigemina, being attached all the way to a roller-like elevation of medullary matter which surrounds the posterior margin of the swallow's nest, and lies immediately before the furrowed commissural band, which passes from the root of the almond-like lobes to the spigot. The swallow's nests [schwalbennester] are semiglobular cavities, which are bounded behind by the root of the almond-like lobes, the furrowed commissural band, and the lateral surfaces of the spigot and nodule; before, by the peduncles of the medulla oblongata, and of the tubercula quadrigemina.

In its approach to the medullary lateral surface of the spigot and nodule, the convex and attached margin of the velum is inclined forward and downward; it then coalesces with the medullary stem of these parts.

The unattached margin of the lateral portion of the velum passes from side to side across the floor of the swallow's nest, below the peduncles of the tubercula quadrigemina and of the medulla oblongata. The superior surface lies unadherent in the swallow's nest, and the rounded extremity of the almond-like lobe rests upon the under.

Near its attachment to the nodule the inner extremity of either lateral portion of the velum is split into two laminæ; the posterior loses itself in the lateral medulla of the nodule; the anterior, which is from two to two and a half lines broad, passes across the fore part of the nodule, adhering to it by its posterior surface; its anterior surface looks to the fourth ventricle. This is the central portion of the posterior velum; the upper and posterior margin of which joins, at an acute angle, the anterior velum, immediately below the vertical process of the central commissure: the anterior velum is adherent to the medulla of the vertical process for a short extent before its union with the posterior.

All these parts, which look to the fourth ventricle, are naturally in close apposition: the cavity of the fourth ventricle is imaginary; but supposing its surfaces separated as by the presence of a fluid, the chamber containing such fluid would appear on a section through the median plane, of a tent-like form; the apex of the tent would be the meeting of the anterior velum with the posterior; its floor the medulla

oblongata; the uppermost of its inclined sides the anterior velum, and the lowermost the peduncles of the annular protuberance and the posterior velum.

For what object are the medullary vela intended? Both have an attachment to the same parts; both are of the same construction; both probably agree in function: one point is evident, that the posterior velum is in relation with the inferior portion of the cerebellum. In the brain of birds the posterior velum does not exist: in the hare its place is scarcely marked by a prominent line: in the sheep and ox the line has become membraniform; and lastly in the horse, the velum, particularly its middle portion, is fairly developed; it covers the anterior surface of the nodule as a medullary membrane lying over against the last lobule of the central lobe, which is covered with a similar membrane derived from the anterior velum. Either flock seems to be, as I have already remarked, the germ of an ill-developed lobe: the nodule may be their commissural portion; the union of which to the flocks is effected by the lateral portions of the velum.

In order to show the parts within the valley, and particularly the posterior velum and its connexions, a cerebellum stripped of its membranes, and hardened in alkohol, is to be thus treated: the square lobes are to be broken off from the peduncles of the annular protuberance as far as to the general commissure: it will then be easy to press together the hemispheres against the superior vermiform process, and thus to evolve the parts contained in the valley, so that the pyramid, the

spigot, the nodule, the swallow's nest, and especially the posterior velum, may come into view; then the biventral lobe may be removed from the under surface, the lateral portions of the hemispheres cut close off to the valley, the almond-like lobes pressed aside, the medulla oblongata divided at the posterior margin of the annular protuberance, and this latter part cut through longitudinally.

Explanation of the Fourth Plate.

Fig. I.

The Cerebellum is reversed, so that its under surface is seen.

a. The surface, from which the soft and biventral lobes have been removed, whereby the almond-like lobes are completely exposed.

b. b. The Almond-like Lobes of either side; the left is entirely, the right partly pressed outwards, and raised from its natural place; whence the left lateral portion of the posterior velum is seen in its whole extent, the right but partially.

c. The inferior and rounded end of the left almond-like lobe raised, which naturally is in apposition with the under surface of the lateral portion of the posterior velum. Between the rounded end of the left almond-like lobe *c*, and the spigot *f*, the transversely furrowed band

is seen, which passes from the almond-like lobe to the medullary lateral surface of the spigot.

d. The Medulla Oblongata, divided and bent forward.

e. The Pyramid.

f. The Spigot.

g. The Nodule bent downward.

h. h. The Flocks.

i. i. The Peduncles of the Medulla Oblongata, or corpora restiformia.

k. k. The under surface of the Peduncles of the Tubercula Quadrigemina.

l. The Anterior Medullary Velum; its inferior surface, which looks to the fourth ventricle, is seen.

m. m. The Posterior Medullary Velum, comprising the central and the lateral semilunar portions. The left lateral portion is entirely exposed, the right is partially covered by the almond-like lobe. The middle portion adheres to the nodule, and its inferior and anterior margin is alone seen. At the inner extremity of the lateral portions a fissure is seen, at which each divides into two laminæ; the posterior of which is continuous with the medullary substance of the spigot and nodule, while the anterior passes above the anterior and upper surface of the nodule, with which it coheres.

Fig. II.

The posterior surface of the Nodule, which naturally is in apposition with the Spigot. There are seven laminæ on this surface: on either side, and attached to this, lie the two semilunar lateral portions of the posterior velum.

a. a. The point at their lower margin, where the lateral portions divide into two laminæ.

Fig. III.

The Nodule pressed downwards and backwards, so that its anterior and upper surface is seen: its apex, looking naturally towards the medulla oblongata, is grey. The base of this surface of the nodule is medullary: the posterior velum is seen adhering to it.

a. a. The point, at which either lateral portion divides into two laminæ.

b. The anterior laminæ of the middle portion of the Posterior Velum.

c. The apex of the Nodule, from which may be counted four laminæ forwards: next is seen an uniform grey surface without furrows; and lastly, the medullary middle portion of the posterior velum.

Fig. IV.

The Posterior medullary Velum, with the nodule completely reversed, so that the upper surface of each is seen.

a. a. The anterior free margin of the lateral portions.

b. b. The outer extremities of these, by which they cohere with the medullary stems of the flocks.

c. c. The posterior and upper convex margins of the lateral portions, which adhere to the margins of the swallows' nests.

d. The middle portion of the Posterior Velum, which passes before and above the nodule, to the root of which it is attached, joining at an acute angle the anterior medullary velum, which reaches the same line. The upper or anterior surface of the nodule is opposed at its base to the anterior medullary velum, at its apex to the medulla oblongata.

Further Inquiries respecting the Structure of the Human Cerebellum, by Professor Reil. Archiven für die Physiologie. Achter-band, p. 273—304.

IV.

Of the Vertical Section through the Middle of the Hemispheres of the Cerebellum.

From the medullary nucleus of the hemispheres, and of the general commissure, the processes, which are to form lobes, lobules, and their further subdivisions, are given off in a radiated manner, encircling the nucleus above, below, behind, and in an unbroken series from the anterior medullary velum to the posterior: their extreme subdivisions, clothed with cortical matter, form the laminæ visible on the surface: these are disposed parallel with each other, and those of either side are united by means of the laminæ of the general commissure. On the upper surface of the cerebellum, the laminæ are disposed in an uninterrupted curve from side to side, the superior vermiform process concurring to form the here indented segment: at the posterior margin, and on the under surface, the curves are completed in each hemisphere, extending from the horizontal fissure of either side to the general commissure; with which, in the valley, the hemispheres are united in a less perfect and uniform manner.

The deep furrows, by which entire lobes and primary processes of the medullary nuclei are separated, are as uniform in different individuals, as the arrangement of the peduncles and the origins of the nerves; but the ramifications of the medullary stems, the subdivisions of the lobes, the number, form, and direction of the laminæ have no constant disposition. The minute description of the final laminated terminations of the lobes, which Malacarne has given, is erroneous as a general account, inasmuch as it is not applicable to a second specimen.

The shallower furrows, which intercept the smaller and subordinate portions, do not pass uniformly from one horizontal fissure to the other: at the posterior margin of the cerebellum, their continuity is fairly broken up, and even on the upper surface it is not uninterrupted, in consequence of the occasional union of the laminæ, which take their rise from one stem. The ultimate laminæ are separated, some by slight indentings, others by well defined furrows; some have a sharp margin, others, particularly those upon the surface, have a broad and rounded margin: some continue single throughout, others unite by pairs, form insulated portions, or distribute themselves arborescently. Upon the upper surface of the cerebellum, the laminæ are disposed more or less concentrically with the general direction of the lobes; laterally they pursue various courses, sometimes dipping obliquely inwards below the level of the neighbouring portions. The arrangement of the laminæ, when stripped of their

cortical matter, bears a great resemblance to the retiform and arborescent appearance of nerves, when deprived of their neurilema: but in the former case the impression merely amounts to a furrow, whereas in the latter it is continued through the substance of the part. It would be interesting to trace the developement of this structure in the nerves of the embryo: there can be little doubt, but that in the brain, the object of this subdivision of the surface, is to gain more space for the extension of the cortical matter.

In order completely to understand the disposition of the nuclei and of the medullary stems in the cerebellum, it is necessary to compare the section of the general commissure with that of either hemisphere: in these sections there is seen an entire difference in the branching of the stems from the nuclei, yet still a provision may be traced for the gradual conversion of the one mode into the other.

In the fifth plate, which is adjoined, a vertical section is given of the left hemisphere of the same brain, which furnished the section of the vermiform processes in plate the third. The mode of branching, as shown by this section, and which alone I had in view, is accurately delineated, though the form of the entire part is not perfect: the whole cerebellum, for instance, is too much flattened, and the roundness of the upper and under surfaces is lost, owing to the position of the part in the vessel in which it was hardened.

Either hemisphere, considered apart, resembles a pyramid, the base of which is behind and below, the apex before and above: we may distinguish two margins, two sides, two surfaces, and four angles in each hemisphere: of the two margins, the anterior is concave, being nearly one half of the semilunar fissure, and marking the mutilated summit of the pyramid; the posterior obtusely rounded margin skirts the base of the pyramid; the inner side is parallel to the vermiform processes, with which it for the most part coheres, being however unattached in the purse-like fissure, the lateral wall of which it forms; the outer side is entirely free, and parallel with the horizontal fissure; the upper surface is slightly curved, the under hemispherical; the former comprises the square and the upper and posterior lobes, the latter, the under and posterior, the slender lobes, the biventral and almond-like lobes: of the four angles the anterior and outer is free, being the extremity of the semilunar fissure; the anterior and inner unites with the fore-part of the general commissure: the posterior angles are both unattached and rounded off; of which the outer is supposed to exist at the meeting of the outer side and posterior margin, the inner at the extremity of the under and posterior lobe in the purse-like fissure.

The section is so made as to divide the hemisphere vertically through the middle of either margin: in this manner all the lobes and lobules, with the exception of the biventral lobe and the almond-like lobes, are justly

divided in their axes. The same process should be employed in this case as in dividing the general commissure: it is expedient to place the cerebellum on its upper surface, to incline the knife somewhat outward, and to carry it at one stroke from the fore, through the back part of the hemisphere.

The section begins at the hollow between the crura cerebri and annular protuberance, passes obliquely through the latter, divides the portio dura of the seventh, and the auditory nerve, the medullary stem of the flock, and the outer extremity of the semilunar lateral portion of the posterior medullary velum. The section passes across the outer part of the swallow's nest, through the corpus restiforme touches the root of the almond-like lobe, and cuts obliquely through the point of the biventral lobe; in continuation, it divides the square lobe, the upper and under posterior lobes, and the slender lobe: it divides, besides, the nucleus of the hemisphere, and the corpus ciliare contained in it, the peduncle of the tubercula quadrigemina towards its outside, the tubercula quadrigemina, and the crus cerebri.

Explanation of the Fifth Plate.

Fig. I.

A section of the left Hemisphere of the Cerebellum; the external portion is that represented.

a. b. c. The Crus Cerebri, Tubercula Quadrigemina, and Annular Protuberance, obliquely cut across from within outwards, and from before backwards.

b. The hole between the crura cerebri and the anterior margin of the annular protuberance.

d. The divided Portio Dura.

e. The divided Portio Mollis.

f. The divided stem of the Flock, to which the lateral portion of the medullary velum is attached externally.

g. 1. The external part of the Almond-like Lobe, which is attached in the valley to the spigot, cut through.

h. i. 2. The Biventral Lobe, which is divided more obliquely; 2. the medullary stem; *h.* the anterior portion, curved towards the medulla oblongata, and touching the flock and almond-like lobe; *i.* the posterior portion, adjoining the slender lobe.

k. l. 3. The Slender Lobe, which unites itself to the pyramid in common with the biventral lobe; 3. its stem, which quickly divides into an anterior and posterior branch.

m. n. 4. The Under and Posterior Lobe; 4. its short medullary stem, dividing into two branches, *m.* the anterior, *n.* the posterior, connected in the valley with the long and the short commissure. In some brains this lobe has two stems projecting from the nucleus, of which the posterior is the largest, and divides into two branches.

o. p. 5. The Upper and Posterior Lobe; 5. its large

medullary stem, which divides into two principal branches, *o.* the posterior, and *p.* the anterior. The single commissure, composed of a single lamina [tab. iii. fig. 1. *f.*] unites the two lobes of this name, which have the longest and largest stems of any of the lobes of the hemispheres; sometimes this lobe enlarges at once, from its connexion with the commissure; sometimes its thickening is gradual: its section is broadest near the horizontal fissure.

q. r. s. 6—13. The Upper and Anterior or Square Lobe: this lobe has eight [6. 7. 8. 9. 10. 11. 12. 13.] medullary stems rising from the nucleus, whereas the other lobes have but one: these numerous stems, however, are individually slighter than the stems on the under surface and posterior margin. Sometimes there are but six or seven medullary stems to this lobe, which are in that case larger, and have more numerous branches. Where the square lobe borders on the upper and posterior lobe, between *p.* and *q.* and 5. and 6. may be remarked always one, sometimes two small and short stems, which do not appear at the surface, but fill up the angle, which results from the great inclination backward of the square lobe, compared with the direction of the upper and posterior lobe: at *r.* is the limit at which the vertical process of the general commissure is separated from the horizontal process: four stems are found on either side of this interval. The furrow between the vertical and horizontal process of the general commissure is deepest at the central point, through which the section in the median plane

passes; here the furrow reaches the nucleus; but on either side it becomes shallower, so that in the section of the hemisphere, the distinction between the vertical and horizontal branch is lost, and the furrows between each of the lobules of the square lobe are all equally deep.

t. The nucleus of the hemisphere, with the corpus ciliare in its middle, which, in the section of the general commissure, is a point only, where the vertical and horizontal processes join, but here is enlarged to considerable dimensions both of height, and length, and breadth: hence the altered relation between the medullary stems and the nucleus: in the general commissure there are but two processes; in the section of the hemisphere there are from ten to thirteen, rising from the nucleus. Behind 6. and 2. behind the square lobe above, and the biventral lobe below, the nucleus becomes much smaller, and is compressed and flattened from above downwards, so that it might indeed here be considered as a stem, of which the upper and under posterior lobes [3. 4. and 5.] are branches.

1.—13. Are thirteen medullary stems, which are seen in this section to spring from the nucleus of the hemisphere: of these 4. and 5. appear the largest, 5. the longest: 1. and 2. the stems of the almond-like lobe, and the biventral lobe, are also large, but they are not fairly seen in this drawing. When these lobes are cut through vertically in their axes, as in fig. II. and III. the stem of the almond-like lobe is seen to be of con-

siderable size, and that of the biventral lobe to be divided down to the nucleus.

The medullary stems vary in number from ten to thirteen: there are seldom fewer than ten. When the number is small, the loss falls on the square lobe. When the stems are numerous, they are individually smaller, and have fewer branches; on this principle the stems in the square lobe are many and simple. In the right hemisphere of the same brain the anterior branch of the soft lobe was slightly furrowed and larger, and the under and posterior lobe was proportionately smaller and less arborescent: the upper and posterior lobes were like those on the left side: the square lobe had eight stems, but the interval between the vertical and horizontal process fell, in this case, behind the fifth stem, as it more generally happens.

Fig. II.

In the vertical section of the hemisphere the biventral lobe is obliquely divided: in the present figure a vertical section of a biventral lobe is represented, carried through its thick and outer extremity, and parallel to the horizontal fissure: either venter in this view has its proper stem rising immediately from the nucleus.

a. A portion of the nucleus, from which the two stems of the biventral lobe spring.

b. The internal stem, which is in apposition with the almond-like lobe and the flock: this is the larger stem, and divides into two branches.

c. The external slighter stem, which leans against the slender lobe.

Fig. III.

The situation of the almond-like lobe is so near to the median plain of the cerebellum, that in the vertical section of the hemisphere, a small external portion only of this lobe is shown. To exhibit the interior of this part in its full dimensions, the lobe should be divided from its point to its base: such a section passes through the stem of the almond-like lobe, the lateral portion of the posterior velum, the swallow's-nest, and the peduncle of the tubercula quadrigemina. The large stem of the almond-like lobe is somewhat contracted near its root; afterwards it expands into an irregular rounded extremity, from which three branches spring, which divide themselves again into minor branches and laminæ.

a. a. a. The peduncle of the Tubercula Quadrigemina, and its continuation with the lateral portion of the posterior velum, through the nucleus, where it contributes to form the upper side of the fourth ventricle, and receives the rounded end of the almond-like lobe in the cavity termed the swallow's nest.

b. The divided lateral portion of the Posterior

Velum, which lies in the swallow's-nest, between the under surface of the peduncle of the tubercula quadrigemina, and the rounded end of the almond-like lobe: *b.* the rounded end of the latter somewhat depressed, in order that the posterior velum may be more distinctly seen, and its manner of connexion with the nucleus.

c. The Nodule.

d. The medullary stem of the Almond-like Lobe, which is directed obliquely upwards and backwards towards the nucleus.

e. e. The convex unattached extremity of the Almond-like Lobe, which looks towards the valley and the medulla oblongata.

f. The apex of the lobe.

g. The side, at which it touches the biventral lobe.

1. 2. 3. Three branches of the stem, of which the slightest, 1. is divided into three portions; the shortest and broadest, 2. into two portions; and the longest, 3. into several.

V.

The Cerebellum separated from behind forwards into two horizontal Portions.

For this object it is necessary to employ a cerebellum thoroughly hardened in alkohol. The separation is effected by tearing the organ asunder at the interval

between the last lobule, and the last but one of the upper and posterior lobe: on gentle pressure made with the thumbs against the opposed surfaces of these lobules, the natural closing of the intervening fissure yields, and the division may be easily carried all round, to the depth of the purse-like notch; a few drops of water poured now and then between the rent surfaces, facilitates the process. Some caution is now required: the separation seldom spreads into the purse-like fissure, by the division of the single commissure, but generally passes below it, so that on the one hand is seen the lamina of the single commissure, on the other the surface of the branch *h.* [Fig. 1. Plate III.] When the horizontal process of the general commissure is thus carefully included in the rent, the separation of the cerebellum into an upper and under portion may be continued to the requisite depth by the means at first employed. The rent passes through the general commissure, below the single commissure [Tab. III. Fig. 1. *f.*] in the uppermost branch of the horizontal process [Tab. III. Fig. 1. *f. g. h.*] as far as the union of the vertical and horizontal processes in the nucleus, or it may be continued as far as the apex of the fourth ventricle, where the medullary vela meet. In the hemispheres the rent begins in the inferior branch *o.* [Tab. V. Fig. 1.] of the stem *o. p. 5.* [Tab. V. Fig. 1.] of the upper and posterior lobes, and passes through their nuclei, over the ciliary bodies, the swallows' nests, and the lateral portions of the posterior velum; laterally, it falls on

each horizontal fissure, runs along it in a direct line towards the origin of the fifth pair of nerves, and ends between this body, the head of the flock, and the anterior and outer angle of the square lobe; in the hemispheres it passes to a greater depth than in the general commissure. The peduncles of the tubercula quadrigemina lie above, those of the medulla oblongata below the fissure, and the peduncles of the annular protuberance are divided by it; the portions thus horizontally separated are held together by the annular protuberance.

This preparation shows the disposition of the medullary substance in the nuclei, and in the stems and branches, which are derived from thence. It admits of a further application: the two portions of the cerebellum may now be separated at their union with the annular protuberance: the upper consists of the square lobes, the upper and posterior lobes, and the superior vermiform process; the lower, of the under and posterior lobes, the biventral lobes, the almond-like lobes, and the contents of the valley: these portions thus separated are flexible, and if bent inwards, disclose the arrangement of the lobes and lobules, their situation, number, and respective directions. It would be expedient to provide many such preparations, with a view to ascertain the most prevalent form, and the principal varieties in these parts; perhaps modelling in wax might be useful on this occasion.

By the separation above described, a peculiar construction is rendered apparent, which, with slight va-

riations, exists in every brain. I will endeavour to describe this as clearly as I can, and I request the reader, for the better understanding my description, to compare it with the adjoined drawings, and with a preparation such as I have employed; he will find, however, after all, that this inquiry will suggest to his mind many more doubts respecting the structure of the cerebellum, than it will clear up. The internal structure consists of fibres, tending from the circumference to the centre: at the circumference the fibres are fine, towards the centre, coarsely fasciculated. The whole exposed surface is naturally divisible into five regions, in which there is an obvious difference of structure. The finer fibres, converging towards an imaginary centre, compose all the stems, which rise directly from the nuclei, as well as their branches and further subdivisions: coarser fibres, on the other hand, more or less interwoven with one another, compose the nuclei. In the preparation, from which the adjoined drawing was taken, the fibres of the nuclei appeared to follow the same general direction with those of the stems: mostly, however, the fibres of the nuclei are bent away in the horizontal plane from the point, at which they touch the radiated fibres of the circumference, so as to form at first an angle with the latter: the tendency to decussation, which chiefly occurs in a direction parallel to the median plane, increases as the coarse fibres are more remote from the circumference, and approach the peduncles, which seem to have a like structure. Traced

along the fine radiated fibres of either surface, and parallel to the circumference, may be seen a ridge, and a light groove or indented line; upon the under surface the ridge is external, and the furrow internal; the reverse is noticed upon the upper surface: the furrow upon the under surface and the ridge upon the upper, mark the meeting of the stems and nuclei.

In the outer region on either side [Tab. VI. Fig. 1. *e. f. e. f.*] the fibres are arranged in four strong fasciculated bands, which decussate each other; a finer disposition, but of a similar kind, seems to prevail in the bands themselves. In the next region on either side, [Tab. VI. Fig. 1. *f. g. f. g.*] the direction of the fibres is more uniform, except where towards the inner margin a round fasciculus ascends obliquely between these fibres, which form a cylindrical canal enclosing it: this fasciculus extends below towards the swallow's nest and the almond-like lobe, on either side. In the middle region [Tab. VI. Fig. 1. *g. g.*] which corresponds to the general commissure, the fibres are throughout fine and uniformly disposed, but are somewhat less so in the nucleus; one fine transverse line alone occurs in this region, at the union of the pyramid with the horizontal process; this line is a slight furrow on the lower, and an equally slight ridge on the upper surface.

Thus the peduncles of the cerebellum are shown to be prolonged backwards in coarse and interwoven fibres which encircle the ciliary bodies, and form the nuclei,

from the surfaces of which a series of finer and radiated fibres, corresponding with the lobes and their subdivisions, diverge.

Explanation of the Sixth Plate.

Fig. I.

The Cerebellum, torn horizontally into an upper and under portion: the medullary surfaces resulting from this division are represented.

A. A. The upper portion of the Cerebellum.

B. B. The under portion.

C. C. The Purse-like Fissure.

D. The posterior surface of the Single Commissure.

E. The upper surface of the Branch *h*, [Fig. 1. Plate III.]

F. F. F. F. The Cortical Substance of the last, and of the last but one of the Lobules of the upper and posterior Lobe, between which the separation is accomplished.

G. G. The projecting inner extremity of the Under and Posterior Lobe.

a. a. The Furrow on the upper portion.

b. b. The Ridge on the upper portion.

c. c. The Ridge on the under portion, which corresponds with the furrow *a. a.*

d. d. The Furrow corresponding with the ridge *b. b.*

b. b. d. d. The lines, within which are the nuclei, without which the stems and their subdivisions; the fibres in the former are coarse and intricate, in the latter uniform, fine, and radiated.

By the lines *e. f. g.* are indicated three regions, in each of which a different organization is observed.

e. f. e. f. f. e. f. e. include the outer region.

h. i. k. l. l. k. i. h. Four strong bands on either side in this region, which cross each other in the substance of the cerebellum, and are themselves composed of fibres similarly disposed.

f. g. f. g. g. f. g. f. The following region on either side, which is placed above the swallow's nest, and has a peculiar structure.

m. A point, from which a bundle of fibres ascends obliquely backwards.

n. o. n. o. The medullary cylinders, and the channels, in which they are lodged; the former are torn across.

g. g. g. g. The internal or middle region, which consists of the rent surfaces of the general commissure.

p. p. A line, at which the under surface is transversely furrowed, and the superior marked by a slight ridge.

q. The fine decussation of the fibres at the bottom of the fissure in the middle region.

Fig. II.

In this figure are represented the cylindrical medullary bodies, which are found on the inside of the region *f. g. f. g. g. f. g. f.* [Fig. 1.] as they appear before the separation above described is completed, which eventually tears them across.

a. a. The upper half of the Cerebellum.

b. b. The under half.

c. c. The Purse-like Fissure.

d. The anterior and upper surface of the branch *h.* [Plate III. Fig. 1.]

e. The posterior surface of the Single Commissure.

f. f. Portions of the Regions marked *f. g. f. g. g. f. g. f.* in the preceding figure.

g. The middle Region.

h. h. The cylindrical medullary bodies, which rise from the under surface in a direction different from the course of the neighbouring fibres, whence they appear to lie in proper canals; they ascend obliquely backwards, and pass to the cortical substance of the commissure of the upper and posterior lobes.

Further Inquiries respecting the Structure of the Human Cerebellum, by Professor Reil. Archiven für die Physiologie. Achter-band, p. 385—426.

On the Structure of the Lobes, and Lobules, and Laminæ, which are placed upon the medullary Nucleus of the Cerebellum.

VI.

The value of these inquiries turns upon the question, whether the structure which I am about to describe exist originally in the organ, or result from its induration in alkohol. Upon this point I shall only observe, that the definite and peculiar arrangement of parts which is found in the hardened cerebellum, appears unlike what we might expect to arise from the influence of a chemical agent upon an uniform pulp; and that it is much more probable, that immersion in alkohol merely unfolds and renders evident an original separateness in the component parts of the brain, which was before too delicate for observation.

To resume our description: the three peduncles on either side may be considered as forming, by their union, two medullary columns, which are directed at first backward and outward; these enlarge into coarsely fasciculated masses, which contain, near the middle of each hemisphere, the ciliary bodies, and are finally in-

clined inwards in a circular course towards the general commissure; the central mass on either side is surrounded by a laminated stratum, and, in union with the latter, constitutes the medullary nucleus: upon the exterior or laminated stratum the lobes and their subdivisions are placed: in the history of the latter two distinct points claim our notice, viz. the structure of each part, and the manner of its articulation with the neighbouring surface. As the same plan is every where followed in these respects, the complete understanding of any single portion of the surface involves a knowledge of the whole.

The lobes, lobules, and their subdivisions, consist of medullary plates, which are arranged in succession, one behind the other, and are parallel to the outward furrows; each medullary plate again consists of fibres, which are radiated, and converge from the circumference, generally towards the centre of each hemisphere, as seen in Plate VI. Fig. 1 and 2; but sometimes, as in the almond-like lobes, another imaginary centre is produced by the peculiar form of the part, towards which its fibres converge. In the stems and branches of the lobes, that is to say, when nearer the nucleus, the fibres are found to be coarser and stronger than at the surface of the cerebellum.

In consequence of their radiated structure, the medullary plates tear very readily in the direction of their fibres, but do not yield any regular fissure, when an attempt is made to tear them transversely. The

fibres have a glittering, bubble-like appearance, when viewed through a microscope.

In brains which have been long in alkohol, and appear thoroughly hardened, threads as fine as those of the silkworm may be raised from the stems, particularly in their middle: whether the substance of these threads correspond in any respect with the cellular texture between the fibres of muscles, is extremely uncertain.

The particular contrivance, which I call an articulation [articulation], exists, wherever subdivision or branching occurs, as of the stem from the nucleus, or of branches from a stem, as well as when a slighter medullary layer lies upon a larger: it may be mentioned here, that the parts of the cerebellum are rather contiguous to, than continuous with, each other: the truth of this position will appear in the sequel. The articulations are disposed in lines parallel to the course of the laminæ, and consist of a projecting linear ridge on one surface, and a corresponding furrow on that opposed to it: the ridges are more or less acute or rounded: the surface between any two ridges is slightly hollowed. The appearance of ridges and furrows has been already represented in the drawing of the horizontal rent of the cerebellum. It is necessary to distinguish from this mechanism those sharp and minute projections which exist in the angle, at which any two branches of equal bulk meet; such projections are acute, and consist of two portions adhering without

an intermediate furrow. Every lamina is naturally separable into two equal lateral portions: at the centre of the base of each lamina is found an angular furrow, which receives the ridge of the surface below. If a lobule be divided in its axis, and from the exposed surface of either half, the medullary plates be successively raised in a direction from the base towards the apex, to that, on which the ridges exist for the articulation of the laminæ; and this last lamina, instead of being raised as the preceding, be peeled off crosswise, medullary plates are seen extending from the ridge into the centre of the lamina. Similar ridges exist on other occasions where medullary plates are joined: the ridges are slighter, in proportion as they are remote from the nucleus. A rent made from the outer surface of a lamina towards the centre, does not pass directly to the nucleus, but from the lamina, through the branch on which the latter is placed, from this branch again through its stem, and so on towards the nucleus. The middle medullary plates of the laminæ do not pass to any adjoining branch, but are continued down the branch on which the lamina is placed. A similar disposition is observed in the connexion between minor branches and larger branches, and in that between the latter and their stems: the exterior plate alone skirts accurately the margin of each subdivision, and may be traced reascending, and lining in succession those beyond: the internal plates follow the course of the stems and branches. These facts may be ascertained when a

lobe is opened from its base and everted. The medullary plates of the stems pass into the branches and their subdivisions, and even into the laminæ.

Having made these general remarks, I will describe specifically each part, beginning at the circumference, and passing inwards to the nuclei: and first of the laminæ*.

The cortical external covering of the laminæ consists of two layers; the outer of which is grey, the inner of a dirty yellow. The outer layer may be removed from the inner, and the inner again from the medulla, leaving smooth surfaces, and apparently without the rupture of an intermediate substance. By immersion in alkohol the cortex becomes white, the

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* By laminæ [blättchen] I mean the ultimate subdivisions of the lobes of the cerebellum, which are composed of a central medullary, and an external cortical portion; for the most part they project at an acute angle; they vary in form, magnitude, and direction. The cortical matter is not confined to the laminæ, it is equally spread over the furrows between them; it is however limited to the surface, with the exception of its contributing to the ganglions within the medulla. The medullary substance of the cerebellum again is every where covered with cortical matter, excepting on the surfaces of the fourth ventricle, the stems of the flocks, the medullary vela, and the peduncles; which parts, it may be presumed from this circumstance, have an office different from the rest.

medulla yellowish, but more so in the laminæ than elsewhere. The cortex is of a looser, more spongy texture than the medulla. These circumstances, and what I have mentioned above, of the continuity of the layer of medulla immediately within the cortex, may lead to the conjecture that the latter is formed as if by precipitation from the investing pia mater, and that its colour changes gradually to yellow, and then to white; and it may even be worth inquiry, whether the whole substance of the cerebellum be not thus formed. One circumstance I would mention in connexion with the preceding remarks, that the pia mater in the fœtus is unusually firm, when there is no distinction between cortex and medulla in the substance of the brain.

The central part of the laminæ consists of slender plates, which lie in close apposition, and admit of being separated. These plates are composed of fibres, which are nearly parallel, are directed towards the extremity of the laminæ, and are covered on every side with cortex. The external plates are reflected from one lamina to another. If the external plates be followed to the centre of the base of any lamina, from the interval on either side intervening between this lamina and the next above and below, they will be found to meet abruptly; and at an angle with their former course, and parallel with each other, and in the axis of the lamina, to pass to its extremity. Where these plates meet is the angular furrow belonging to their articulation, beginning at which it is easy to separate the lamina into two equal and similar portions.

Intermediately between the external plates thus described, other medullary plates, derived from the medulla of the branch itself, enter each lamina, which may be distinctly traced for at least half of the length of the lamina.

From the lateral surface of a lobe or lobule, lamina after lamina may be successively removed with the handle of a scalpel and the forceps: along with each lamina a medullary plate is torn down; the first of which, that namely corresponding with the lamina nearest the base, may be traced reflected along the opposite surface of the adjoining branch. At the point where the lamina is first raised, and at the place of its natural articulation, a ridge is seen: if the next lamina be raised, another ridge is seen, belonging to the articulation of the second; and if this be then drawn towards the base of the lobe, along with its corresponding medullary plate, the ridge is lost, on which the former lamina had been placed, but remains still distinct upon the plate last separated. In this manner the laminæ on each side of a lobule may be removed to the central plates. Every lamina, however, does not bring away with it a medullary plate: whether it be, that all the laminæ have not a plate derived from the centre of the branch, or, that if they have, its slightness renders it often impossible to remove it singly. Thus a lobule is peeled from the outside to its central plate, much in the manner of various parts of plants.

If a lobule be selected, the laminæ of which pass off

at a right angle nearly, and one of these be pressed towards the apex, and upon its thus exposed surface a slight incision be made, the thin medullary plate, which may then be raised, will not pass from the base of the lamina along the axis of the lobule; but will be found continuous with, or reflected so as to form the outer medullary plate of the lamina next in order towards the base of the lobule. A similar result ensues, if an incision be made upon the external margin of a sufficiently broad lamina in the direction of its axis, and either lateral portion be pressed towards the adjoining lamina; the separation will continue down the first parallel to its axis, and then ascend the second lamina in the like direction. If again the cortical matter be removed from a few laminæ, and from one surface of a thus denuded lamina a fine layer be drawn with the forceps, the rent will first descend parallel to the axis of the denuded lamina, then run at an angle along the interval leading to the next lamina, which it will in turn ascend.

If a thin lobule be torn asunder in its axis, and its layers be raised in a direction from the base towards the apex in succession, so as to leave the external layer only, there is an appearance as of cylinders lying in close lateral apposition: the projections in this case correspond with the intervals between the laminæ; and the angular furrows, to the axes of the laminæ: each lamina will open at these furrows, and finally divide into two equal portions. If care be taken not to complete this separation, each lobule, and even each entire

lobe, may in this way be unfolded, and its arborescent appearance converted into that of an expanded membrane. The better mode of thus unravelling a lobe is the following: a portion about an inch broad is to be cut out of a fresh cerebellum, and placed for from twelve to twenty-four hours in a weak solution of caustic potass, then in distilled water for some hours more, and finally left for from twenty-four to forty hours in pure alkohol. Very little force is necessary to unfold the parts of such a preparation in the order above described. By a somewhat similar process the medullary plates of the lobes and lobules may be shown: an indurated cerebellum is to be placed in a weak solution of caustic potass, for from twenty-four to forty-eight hours, and subsequently reimmersed in alkohol for a few days, if the solution of potass has rendered it too soft. From a lobe thus prepared, the laminæ, with their adherent medullary plates, may be easily separated in succession. When several laminæ have been removed, it may well be seen how one or more plates of the central medulla of each lobule enter the furrow at the base of each lamina, and proceed towards its margin. The same observation may be varied by drawing off, in the direction of the furrows, the external medullary plates. If a lobule be split from its base, the fissure does not always proceed to the circumferental extremity, but often breaks short off into the centre of a lamina.

The composition of the lobes and lobules is accurately the same as that of the laminæ; only that the

medullary axes of these larger parts are larger in proportion; but they equally admit of a central division, and their outer layers are reflected in a similar manner along the opposite surfaces of the adjoining similar parts. For the articulation of a branch with a stem, a lobule with a lobe, the latter shows at the line of separation a slight projecting ridge, which is received into a furrow in the latter. If the square lobe be broken off from the nucleus, and the laminated stratum be peeled from its internal surface, an appearance of apposed cylinders, or of parallel raised surfaces, with intermediate furrows, is seen; resembling, though on a larger scale, the internal surface of the laminæ. The entire lobe may be then unfolded, the separation commencing at the intermediate furrows: the parallel raised surfaces again correspond to the intervals between the lobules; they are not always rounded, but sometimes angular and wedge-like. Finally, the lateral plates of the lobules are reflected to the opposite sides of the neighbouring lobules, and the entire lobe itself, as well as the lobules, laminæ, and their investing cortex, seem as if they might be the result of successive depositions from the surface. Hence it is that rents from the circumference toward the centre do not penetrate the nucleus, with the exception indeed of that carried between the upper and under posterior lobes, which is represented in Fig. 1. Plate VI. In this case the rent is successfully carried through, in consequence of striking an interval between the circularly disposed fasciculi, which enclose the ciliary

bodies: the rent has every appearance of doing violence, and the radiated fibres of the lobes meet those of the nucleus at an angle.

The lobules are articulated by means of ridges and furrows with the nucleus. To the square lobe there are mostly but three strong ridges, and several lobules attach themselves to the anterior of these; hence the ragged appearance of this ridge, when the lobe in question is broken off. When the square lobe is raised from the horizontal fissure towards the superior vermiform process, a similar appearance is seen to what occurs in stripping the medullary plates cross-wise from the laminæ; viz. that of medullary plates entering the central furrows from the ridges, which correspond with them.

From what has been said it appears, that in the structure of the lobes, plates composed of medullary fibres are merely laid in successive layers upon the nucleus; a remark which is confirmed by these additional facts; that there is no relation between the volume of the hemispheres and that of the medullary columns; that the medullary substance of the branches does not diminish in proportion to the minor branches given off from them; that the radiation in the lobes has in many places a different direction to that in the nucleus; and lastly, that the lobes and lobules of either surface overlap the medullary columns on either side of the horizontal fissure. It appears that the fibres from the circumference crowd together towards an imaginary centre, and thus exhibit internally an ir-

regularly fissured surface, when they reach the nucleus, the next part for our consideration.

Immediately within the lobes a laminated stratum exists, which forms, on the one hand, the surface supporting these processes, and on the other, the exterior shell of the nucleus. This it is, which requires to be peeled from the internal surface of the square lobe, after its removal, as above alluded to, in order that the alternate risings and furrows at the base of its lobules may be seen. I have been able frequently to raise two, three, and more medullary plates in succession, between one ridge and another, especially between the posterior ridges. It would seem as if the component fibres run across each intermediate furrow, and meeting, form each ridge, and mount together into the lobules. There are found, besides, some coarser fibres in the direction of the ridges, which cannot be raised without breaking up their adhesion to the sides of the medullary columns; perhaps these are but layers, which serve to fill up the intervals: the stratum itself seems, as the preceding parts, to be formed in layers, as by successive depositions.

The last part is the stratum of coarse and curvilinear fasciculi, which is specially continuous with the lateral peduncles of the cerebellum, and together with the anterior and posterior peduncles and the ciliary body, constitutes the central part of the nucleus of either side. The lateral peduncles ascend backwards and outwards in the horizontal fissures, expand them-

selves in the upper and under portions of the hemispheres, and at the same time incline inwards, being curved more abruptly at the fore part than near the posterior margin. The anterior division of fibres throws itself over the anterior peduncles, and with the next set pursues a course towards the general commissure: a third set of fibres passes parallel to the medulla of the general commissure, towards the purse-like fissure, to the posterior margin of the posterior lobes, the radiated fibres of which are placed at an angle upon them. If, on the removal of a portion of the posterior lobes, part of the nucleus is brought away besides, the two portions either naturally separate, or are only retained by their mutual indenting, the furrows for which are parallel to the circular course of the fibres of the nucleus. Between the middle peduncles, which form the capsule of the ciliary body, (which consists of lobes again, and may be raised from this capsule) and the anterior peduncles, the posterior plunge; and along with the middle peduncles, mount over the anterior. The anterior peduncles pass directly backwards, pierce the lobes of the ciliary body with delicate fibres, and lie close upon and parallel to the anterior velum, and the nucleus of the general commissure. On another occasion I propose to return to this subject, and to give a fuller account of the nucleus and its peduncles.

Explanation of the Plates.

Plate VII.

Fig. I.

This engraving represents the surface exposed by tearing off the square lobe, which is effected in the following manner. Its anterior angle is first raised by means of the handle of a scalpel, from the peduncle of the annular protuberance, and then the whole external margin of the lobe is carefully detached as far as the posterior angle; in general, a portion of the upper and posterior lobe is raised along with this: the fissure thus begun, is continued towards the general commissure, by continually raising the partially detached lobe with the finger or the handle of the scalpel: during this process, the ridges are brought into view, with which the lobules of the square lobe are joined, and towards the vermifôrm process the yet unbroken medullary plates are seen rising from the ridges and entering the lobules. On either side of these medullary plates are fissures separating them from the outer plates, which, if enlarged with the handle of the scalpel, show more distinctly the rise of the central plates,

in the middle of the lobules: the lobe may now be broken abruptly off, close upon the general commissure.

The shallower the layer, which is thus raised, the more distinct is the appearance of the ridges, on which the lobules rest, of the outward sloping furrows, which lie between these, and of the fissures in the centre of the lobules. The surface thus exposed, consists of the laminated stratum, which lies above the nucleus. The layers are piled most thickly anteriorly, towards the central lobe; they pass in a curvilinear direction towards the fore part of the superior vermiform process, above the peduncles of the tubercula quadrigemina, and add to the thick fasciculus, in which the peduncles of the annular protuberance cross over the latter: the fibres of these plates seem to pass transversely from ridge to ridge. If the preceding method should fail, the lobuli may be removed singly, by means of the handle of the knife; a trial being made, on the removal of the first or second, to effect the raising of the whole lobe, at the requisite level: if the rent be made at a greater depth than that above described, a coarsely fasciculated stratum is exposed, which is inclined inwards, encircling the ciliary body. The removal of both the square lobes in this manner facilitates the complete exposure of the under surface of the cerebellum. In the adjoined drawing the square lobe of the left hemisphere, to its juncture with the superior vermiform process, the first lobule of the upper and superior lobe, and

the anterior half of the second, are represented as broken away: the cerebellum is inclined obliquely towards the right side.

a. The Right Hemisphere.

b. The Left Hemisphere.

c. c. The Superior Vermiform Process.

d. The Purse-like Fissure.

e. The Tubercula Quadrigemina.

f. The Left Peduncle of the Tubercula Quadrigemina, freed from the central lobe, and therefore exposed to its connexion with the nucleus, where the peduncle of the annular protuberance crosses over it.

g. A point, at which a greyish substance of looser texture appears, from between the anterior, and middle peduncles; it is a process of the ciliary body. This substance, which shrinks in alkohol more than the neighbouring parts of the cerebellum, and when exposed to the air dries more quickly, is easily separable from the medulla of the nucleus; in this case, its shrinking had produced a spontaneous separation.

h. A triangular portion of the Crus Cerebri, interposed between the peduncle of the Tubercula Quadrigemina, and that of the Annular Protuberance: there is a groove marking the boundaries of these parts on either side of the crus cerebri meeting its fellow at an angle.

i. The Peduncle of the Annular Protuberance.

k. A part of the upper surface of the Peduncle [*i.*] which is smooth externally, where it forms the floor of

the horizontal fissure; but internally grooved, where it forms a centre, from which fibres diverge on all sides constituting the nucleus. This surface is best seen in a cerebellum previously hardened in alkohol, and afterwards immersed in a weak solution of potass. Vessels either numerous or of large size enter at this point.

l. The medullary substance of the same Peduncle, extending itself to the Lobules of the Upper and Posterior Lobe; with the sloping surface of the laminated stratum, which is continuous with the central plates in the lobules of the square lobe.

m. m. m. Three somewhat rounded ridges, having deep excavations interposed, from which the medullary plates arise, which enter the lobules of the square lobe: the first is the most intricate, the circular fibres of which pass inwards over the peduncles of the annular protuberance; with these are articulated all the anterior lobules of the square lobe, which are connected with the vertical process of the general commissure. These lobules are in part inclined forward; others are vertical or inclined slightly backward.

n. A slighter ridge, upon which the medullary stem of the first lobule of the Upper and Posterior Lobe is placed.

o. o. Delicate ridges corresponding with laminæ.

Fig. II.

represents the surface exposed, by breaking off, in a similar manner, the biventral and slender lobe, half of the almond-like lobe, and that surface of the lobule of the under and posterior lobe, which lies nearest to the slender lobe. The handle of the scalpel is directed under the biventral lobe, over the extremity of the flock, and the peduncle of the annular protuberance, so as to raise the outer margin of the biventral and slender lobes. Then the surface of the under and posterior lobe nearest to the slender lobe is to be broken through to the nucleus, and the rent carried laterally towards the valley, as far as to the middle of the almond-like lobe, where the fissure is to terminate, being directed along its axis to the surface. The surface now exposed is covered with ridges and intermediate depressions, like the former, beneath which likewise a laminated and sloping stratum lies.

In this figure, the biventral and slender lobes are supposed to be entirely removed on the left side, as well as the neighbouring surface of the under and posterior lobe, and the outer half of the almond-like lobe, to the depth of the nucleus.

a. a. The Crura Cerebri.

b. b. The Annular Protuberance.

c. The Medulla Oblongata cut through, and somewhat inclined to the right.

d. The right Hemisphere.

e. The left.

f. The Pyramid.

g. The outer margin of the Square Lobe.

h. The Peduncle of the Annular Protuberance.

i. The Flock.

k. The Almond-like Lobe broken in half.

l. The point upon the under surface of the Peduncle of the Annular Protuberance, from which fibres diverge, and expand into the under portion of the nucleus.

m. A considerable ridge, on which the biventral lobe is articulated; this divides towards the almond-like lobe into two lines, the anterior of which passes to the posterior margin of the stem of the almond-like lobe, the posterior towards the stem of the pyramid.

n. A second ridge, somewhat more marked, with which the slender lobe is articulated; between these ridges, and on either side of them, shallow depressions or channels exist.

o. o. o. The broken stem of the Under and Posterior Lobe, upon which the slight ridges for the laminæ of its anterior surface are seen. Into the divided laminæ, which remain on the side nearest the pyramid, medullary plates may be seen passing from the ridges.

Plate VIII.

Fig. I.

The vertical section of a small lobule, from the circumference of the Cerebellum, seen in its natural size as well as magnified, upon which there are five laminæ. The two undermost laminæ on the right side are split in their axes, and drawn away from the lateral surface of the lobule. The furrow at the centre of the base of each lamina, and the corresponding ridge, are seen.

For this preparation, a thin lobule, or the half of one divided in its axis, may be taken, and cut into strips of the thickness of a quarter or an eighth of an inch. The laminæ may then be raised with a blunt instrument from the base towards the circumference. The fissure will run along the surface of the branch, separating the laminæ from it, and dividing each in its axis. In this way, the entire series of laminæ on one side of a branch may be raised, and unfolded, and each lamina finally divided.

Fig. II.

A portion of the surface of an hemisphere covered with cortex, which is prepared in two ways, to show

the reflection of the medullary plates from the lateral surface of one lamina, over the opposed surface of that adjoining. The portion taken should have laminæ sufficiently broad, and such as rise vertically form a lobule: upon the external surface of one of these laminæ an incision is made parallel to the course or axis of the lamina, one half of which is then pressed towards the neighbouring lamina. The rent passes down the centre of the first lamina, and is reflected up the centre of that adjoining, which it divides, thus cutting out a wedge-like portion.

a. The two laminæ, the adjoining surfaces of which are broken away.

b. The wedge-like portion from the two laminæ everted.

The object is still better attained by separating two laminæ, and removing the cortex from the opposite surfaces, and then making a slight incision upon one of them; if the layer cut through be drawn out with the forceps, the rent, as before, descends the first, and is reflected up the adjoining lamina.

c. c. The furrow between two laminæ opened.

d. d. The limits of the surface, from which the cortex is separated.

e. e. The medulla of two laminæ stript of its cortex.

f. The spot where the exterior medullary plate is removed from the opposed surfaces of the two laminæ.

g. The portion removed.

Fig. III.

The vertical section of a stem with two branches.

a. The stem.

b, c. Its two branches.

b. The upper branch split in its axis; its two portions, when pressed together, leave an angular furrow opposite to the point at which the stem divides.

d. The central medulla of the larger branch continuous with that of the stem: at the angle where this branch and the stem join, the ridge is seen, which corresponds with the furrow above described.

In this preparation it is seen, that the branches unite with the stem in the same manner as the laminæ with the branches. The preparation is best made by selecting the posterior lobules of the square lobe after its separation, then pressing the laminæ off from one surface of a branch, and carrying the rent down that surface, whence it is reflected along the opposite surface of the adjoining branch.

Fig. IV.

The almond-like, the biventral, and slender lobes are broken away from the under surface of the cere-

bellum. The inner extremities of the biventral and slender lobes bordering upon the valley are seen in a vertical section.

a. a. The nucleus of the right hemisphere cut through vertically.

b. c. The under surfaces of the nucleus, from which portions of the biventral and slender lobes have been removed.

b. The ridge for the biventral lobe.

c. The ridge for the slender lobe.

d. One surface of the biventral lobe.

e. The slender lobe; its two outer surfaces with their laminæ are separated from the central medullary plates, which remain upon the ridge, and ascend into the two upper laminæ. The outer surface on the right is reflected, so as to be continuous with the neighbouring surface of a lobule of the under and posterior lobe; that on the left is directly reflected to the biventral lobe. In the interval corresponding with the second reflection is the apex of a trifling lobule, which is likewise split in its axis. The central plates of the biventral lobe are separated from its ridge, which is thrown towards the left.

Fig. V.

The square lobe of the right side broken off from the nucleus, and its under surface represented.

The outer margin, at which its lobules overhang

the horizontal fissure, is here on the left; the inner margin, which should join the superior vermiform process, but is here obliquely divided, is on the right; the anterior margin, which contributes to the semilunar notch, is above; the posterior, which borders on the upper and posterior lobe, is downwards.

The laminated stratum, upon which the square lobe is placed, is here removed. The lobules may be opened in their centre after this, as has been in the present instance effected in nine; above, two lobules, and below one, remain unopened.

Fig. VI.

The internal medullary surface of a portion of the slender lobe torn through in its axis. The two posterior lobes, which have still broader lateral surfaces, would serve as well for this preparation, and the brain should not be too much indurated. From the margin of the medullary surface nearest to the nucleus, a medullary plate is to be raised, after a shallow incision, and then drawn obliquely off with the forceps: a few drops of spirit should be poured upon the part during this process. In this way are exposed the furrows, indicating the axes of the laminæ, the intermediate convex surfaces, the ridges, and the medullary plates passing from the latter into the furrows.

a. a. The internal medullary surface of a portion of the slender lobe, opened in its axis.

b. The cortical substance of that surface of the lobe, which borders on the under and posterior lobe.

c. c. Places, where the medullary, as well as the cortical substance, has been broken through in the separation of the removed portion.

d. Raised lines visible on the rent surface, which are sections of medullary plates passing into the centres of the laminæ.

e. A medullary plate raised in a direction obliquely towards the surface, and from left to right: at its under surface the articulating ridges are seen, which correspond with the opposite furrows. At the point where the partially raised layer joins the lobe, strong medullary plates may be seen passing from its ridges into the furrows.

Fig. VII.

A lobule of the biventral lobe divided in the middle; its medullary internal surface represented.

a. a. The surface delineated, as it appears immediately after its separation; it presents an appearance of grooves, fibres, and laminæ, which is more readily comprehended when seen than from description.

b. b. The last lamina of the superior margin divided.

c. c. A wedge-like portion, composed of half the lamina next on this side adhering by the reflected external medullary plate.

1. 2. 3. 4. 5. 6. 7. Seven strips of medullary plates raised in succession; of which 1. enters the furrow in the lowest lamina; 2. that in the next above, and so on. The medullary stem consists of plates, of which the outer enter the furrow of the lowest lamina, and so on in succession.

d. A surface, from which the central medullary plates are entirely removed, so as to show the furrows of the laminæ; the natural separation continued from the furrow of each along its axis, is shown on the obliquely divided surface: between the internal furrows the convex and parallel surfaces are seen, which correspond with the external furrows.

e. A medullary surface turned back, exhibiting as many ridges, as there are laminæ upon this half of the lobule.

Fig. VIII.

A broad medullary plate, from the under and posterior lobe of the right hemisphere of the cerebellum, to which a part of the circular fibres of the nucleus adheres.

a. a. The marginal laminæ stript of their cortex.

b. b. The portion corresponding to the under and posterior lobe.

c. c. The line at which the fibres of this lobe are placed on the nucleus. These fibres are more delicate, and converge towards the centre of the hemisphere:

upon their lateral surface several ridges are visible, for the articulation of lobules and laminæ.

d. e. The portion belonging to the nucleus.

d. A point, at which the circular fibres of the nucleus are inclined more abruptly inwards: the radiated fibres of the lobe are placed almost perpendicularly upon these, and may easily be raised from them.

e. A point more internal, at which the curved fibres have the appearance of being continuous with the radiated fibres.

f. The margin, at which the stratum of curved fibres was separated from the peduncles of the annular protuberance.

Fig. IX.

A convolution of the cerebrum previously hardened in alkohol, and rent from within outwards.

a. a. The cortical substance.

b. The medullary substance, the radiation of which is towards the circumference.

c. The surface directed towards the nucleus of the cerebrum.

This engraving, though from an indifferent specimen, may give some idea of the structure of the convolutions, which are placed on the nucleus of the cerebrum; they are all of similar fabrick, and form the greater part of the brain. The cerebrum is composed after a similar type to that of the cerebellum; it has a

nucleus, and organs, which encircle it. The convolutions of the brain, like the laminæ of the cerebellum, consist of medullary plates, as these plates again, of fibres, and their exterior surface is covered with a layer of cortical matter; but they are not collected into stems, and they are far larger and stronger than the laminæ of the cerebellum. The medullary plates are least adherent in the centre of the convolutions, but are not so easily separable as the laminæ of the cerebellum, on account of their incurvation. The layers of medulla have a radiated fibrous structure, the feather-like radiation being directed towards the circumference: hence it is easy to raise the fasciculi from the nucleus outwards, but they will not tear transversely. The cortex is easily separable from the medulla; it lies, at the surface of the convolutions, in the same line with their fibres; laterally it seems to be disposed at right angles to them.

Appendix to the Anatomical Observations of Professor Reil on the Cerebellum. Archiven für die Physiologie. Neunterband, p. 129—135.

VII.

The square lobe includes the greater portion of the anterior and upper surface of the cerebellum, is bounded internally by the superior vermiform process, before, by the semilunar fissure, externally by the horizontal fissure, and behind by a deep furrow (interposed between it and the upper and posterior lobe), which extends in a circular direction from one horizontal fissure to the other, and passes through the upper vermiform process before the single commissure. This lobe lies over against the under and posterior, the slender and biventral lobes, and the flock in the horizontal fissure; and its anterior angle is so far advanced as to be placed vertically above the origin of the fifth pair of nerves.

The upper and posterior lobe is bounded on the fore part by the furrow above described, behind by a similar furrow, which separates it from the under and posterior lobe. The two lobes of this name are united by the single commissure in the purse-like fissure, include the posterior portion of the upper surface of the cerebellum, and part of its posterior margin, and externally lie over against the under and posterior lobes in the horizontal fissures.

The under and posterior lobes are separated, before, from the upper and posterior, and behind, from the slender lobes, by deep furrows; are internally broad where they are united by the short commissure [Tab. III. *h*.] and the long and concealed commissure, which in truth consists but of the laminæ of the under surface of the same stem, that furnishes the short and exposed commissure. The external margin of these lobes on either side is narrow and pointed, lying over against the extremity of the upper and posterior in either horizontal fissure. These lobes complete the posterior surface of the cerebellum.

The slender lobes are not constantly separated from the preceding, but always from the biventral lobes, by a furrow, which sinks to the depth of the nucleus: they are united in the valley by the pyramid, and in the horizontal fissures they lie over against the square lobes, and are in contact with the flocks.

The biventral lobes are divided in the middle: each has the form of a wedge, the point of which reaches the valley, and its base the horizontal fissure; they are incurvated somewhat towards the valley, and the furrows between their marginal laminæ run parallel with the medulla oblongata. In the horizontal fissures they are in contact with the flocks, and in the valley the apex of either joins the medullary stem of the pyramid laterally.

The almond-like lobes are depressed towards the valley, are situated between the biventral lobes, the pyramid, the spigot, and nodule, with their rounded

internal extremities in the swallows nests. Their medullary stem is attached to the pyramid, along with that of the nodule and spigot.

In order to shew the connexion of the lobes and lobules of the hemispheres with the general commissure, and the composition of the latter, the opposed surfaces of the different lobes should be stripped of their laminæ; at the bottom of each furrow is thus exposed an angular surface, being part of the laminated stratum which supplies the lobes with ridges of articulation and central medullary plates.

The lobules of the square lobe are separated by uniformly deep furrows every where, but near the vermiform process, on their approach to which several lobules adhere to one stem. This is the cause why a greater number of medullary stems is seen in the section of an hemisphere [Tab. V. Fig. 1.] than in that of the general commissure [Tab. III. Fig. 1].

The nucleus of the general commissure is situated at a deeper level than that of either hemisphere, partly owing to its smaller bulk, partly to the exclusively vertical direction of its branches; hence the cup-like depressions between its lobules, when they are separated. The most capacious of these exist between the stems [Tab. III.] *d. e.* and *e. g.* of which the posterior again is the larger cavity. If at this point the surface be rent from behind forwards, or the pyramid be split from its apex to its base, the round and nerve-like fasciculi [Tab. VI. Fig. 1.] are exposed, which ascend towards the purse-like fissure, and are apparently con-

tinuous with the anterior peduncles. The remaining hollows are of inferior depth: similar depressions exist upon the under surface, the first behind, the second before the pyramid, and the third between the spigot and nodule.

The single commissure, which connects the upper and posterior lobes, is sometimes concealed between the last lamina of the superior vermiform process, and the uppermost in the purse-like fissure; but for the most part it appears as a distinct transverse band upon the surface. The single commissure has an even cortical surface, except laterally, where it is joined above and on the fore part by the last lamina of the square lobe, and below by the first lamina of the under and posterior lobe.

The pyramid is the principal portion of the inferior vermiform process; its medullary stem enlarges laterally, and is connected with all the lobes of the under surface, and with the eminences in the valley. The spigot and nodule have scarcely distinct stems, but join themselves laterally to the stem of the pyramid. If the posterior surface of the pyramid be peeled away, the rent removes at the same time the long commissure; if its anterior surface, the rent removes the neighbouring surface of the spigot. The nodule may be split from its apex to its base, where the portions break off.

The upper and posterior lobes are joined directly by the single commissure; the under and posterior lobes by the short and long commissures; the slender lobes by the long commissure and the pyramid; the

biventral lobes and the almond-like lobes are continued vertically into the stem of the pyramid. The lobules of the upper surface of the hemispheres lie on the same plane nearly with the superior vermiform process; those of the under surface extend greatly beyond the level of the inferior; hence it happens that the inner extremities of the posterior, slender, and biventral lobes, seem as if abruptly cut away.

The stem of the flock divides into two roots, one of which passes round the posterior margin of the swallow's nest to the pyramid, the other transversely across the peduncle of the medulla oblongata to the central depression in the floor of the fourth ventricle; between the two, the outer corner of the lateral portion of the medullary velum joins the stem of the flock.

The anterior medullary velum connects the peduncles of the tubercula quadrigemina, is composed of fibres similarly arranged with those of the peduncles, passes backwards towards the purse-like fissure, and is connected with the stems of the upper and under vermiform processes.

All the lobes and lobules are arranged upon surfaces of the lateral peduncles; even the upper and posterior lobe is placed upon its posterior margin, or it may be said that the peduncle of either side terminates in this lobe; hence the difficulty of reflecting the laminated surface of this lobe, continuously with that of the adjoining lobes; such a rent generally extends into the nucleus.

Experiments to determine the Influence of the Portio Dura of the seventh, and of the Facial Branches of the fifth Pair of Nerves.

The only unexceptionable evidence respecting the influence of individual nerves in human beings, consists in the record of cases, in which, through accidental violence, or in surgical operations, single nerves have been divided in the living human body. In default of such evidence, the next measure is to collect the results of experiments made on animals: if by this method it be discovered that corresponding nerves in different kinds of animals have uniformly similar functions, it may be presumed that the like nerves in man have offices not materially different. With the view of contributing some materials to serve as data in an argument of this nature, I shall describe the distribution of the portio dura, and of the second and third divisions of the fifth, in the ass, together with the phenomena ensuing on the division of several of their branches, and on that of the frontal nerve.

The portio dura in the ass passes obliquely outwards and downwards after its exit from the cranium, being covered by the parotid gland, to which it adheres, and reaches the root of the condyloid process of the lower jaw, where it is joined by two large branches from the third division of the fifth: previously to this,

the nerve sends a small ascending branch to the ear, a larger, which passes before the ear to the muscles of the forehead, including the orbicularis palpebrarum; and a third, which runs in a contrary direction, to the angle of the jaw, supplying the cutaneous muscle: in most instances, likewise, the nerve receives one or two exceedingly fine filaments from the third division of the fifth, before it is joined by the greater branches which I have mentioned. The common trunk formed by the union of the latter with the portio dura, runs along the cheek, parallel with the jugum, and sends one or two or three branches towards the base of the jaw: these filaments, whether given off singly or together, chiefly supply the cutaneous muscle; but one portion always passes to the muscles of the under lip. The common trunk is now inclined forwards, dips beneath the long muscles of the nostrils and upper lip, crosses over and adheres to the infraorbital nerve, with which several of its fibres are directly continuous; it then terminates in branches, which enter into all the muscles of the nostrils and upper lip.

A frontal nerve from the first division of the fifth, emerges upon the forehead.

The second division of the fifth, after leaving the skull, crosses the sphenomaxillary fissure, in which it gives off four small branches, distributed to the posterior alveoli, the palate, and membrane of the nose; upon the uppermost of these the ganglion is formed, from which the vidian nerve is reflected backwards. The trunk itself scarcely diminished in size, passes

along its bony canal, sending numerous branches to the alveoli, and finally emerges upon the face, where its fibres seem to enter into all the muscles of the upper lip and nostrils, but seem principally to tend towards the margin and internal surface of the lip.

The third division is larger than the second; it sends off at once four branches: the *first* to the pterygoid muscles; a *second* to the masseter and temporal muscles; a *third* to join the portio dura, in the manner above described, a filament from which is reflected to the base of the skull, at the inside of the glenoid cavity, and another to the external ear; and lastly a *fourth*, which gives branches to the soft palate, and then passes outwards, between the two processes of the lower jaw, inclining obliquely downwards, and lying afterwards between the masseter and the bone; in continuation it runs along the under margin of the buccinator muscle, which it supplies, and is finally distributed to the mucous surface of the under lip. The trunk of the third division next divides into the gustatory branch, which sends off the chorda tympani, and then pursues its course by the side of the tongue; and the inferior maxillary nerve, which passes along the canal in the lower jaw supplying the alveoli, and on emerging from it, is distributed to the flesh and integuments of the under lip.

Experiment 1. The infraorbital and inferior maxillary branches of the fifth were divided on either side, where they emerge from their respective canals: the lips did not lose their tone, or customary apposition to

each other and to the teeth; but their sensibility seemed destroyed: when oats were offered it, the animal pressed its lips against the vessel which contained the food, and finally raised the latter with its tongue and teeth: on pinching with the forceps the extremities nearest the lips of the divided nerves, no movement whatever of the lips ensued: on pinching the opposite extremities of the nerves, I observed that the animal struggled violently, as at the moment of dividing the nerves: these latter results uniformly attend the division of the nerves above mentioned, and of that branch of the fifth which joins the portio dura. Some days afterwards, though the animal did not raise its food with its lips, the latter seemed to be moved during mastication by their own muscles.

Experiment 2. The common trunk composed of the portio dura and a branch of the third division of the fifth was divided upon the masseter muscle on either side: the lips immediately fell away from the teeth, and hung flaccid, and the nostrils lost all movement. The sensibility of the lips appeared unimpaired; the animal raised its food as in the former instance. When the extremity nearest the lips of either divided nerve was pinched, the muscles of the lips and nostril on that side were convulsed.

Some days after this, the frontal nerve was divided on one side of the forehead of the same ass; when the neighbouring surface appeared to have lost sensation, but its muscles were not paralysed.

Experiment 3. The portio dura was divided on either

side immediately before its union with the branch of the fifth pair; the muscles of the lips and nostrils seemed as thoroughly paralyzed, as in the preceding experiment.

Experiment 4. That branch of the fifth which joins the portio dura, was divided on either side; at first the under lip appeared to fall away from the teeth, but not to the same degree as in the two former instances; at times the lips were justly closed; and the animal invariably raised with its lips, as readily as before the division of the nerves, the oats, which were at intervals offered it. The asses employed in these experiments, with the exception of the first two, were killed as soon as the effect of the operation had been satisfactorily ascertained, in order to determine by dissection, whether the division of the nerves had been completely effected: in this instance, it was found that on one side, a fine filament of the size of a common thread passed from the branch of the fifth to the portio dura, before the place of the division of the former; no difference had been observed between the action of the muscles on either side of the face.

Experiment 5. A repetition of the preceding; but on one side a larger filament had been left undivided; in this case the under lip did not hang down; no difference had been noticed between the action of the muscles of either side.

Experiment 6. A repetition of the preceding, with exactly the same result as in experiment 5th; and still on one side a filament of the size of a thread

had been left, uniting the fifth with the seventh. Upon the same animal, the infraorbital and submaxillary nerves were divided: the under lip was now observed to hang down a little on one side; but this circumstance seemed fairly attributable to the very extensive division of the muscular fibre on that side. The portio dura was finally divided on one side, where it emerges from the skull; the animal was observed to lose instantly the power of closing the eyelids on that side; to determine which point alone the division of the 7th, near the skull, had been intended.

I infer, from the preceding experiments, that in the ass, the portio dura is a simple nerve of voluntary motion; and that the frontal, infraorbital, and inferior maxillary, are nerves of sensation only, to which office, that branch of the fifth which joins the portio dura probably contributes: and from the preceding anatomical details, that other branches of the third division of the fifth, are voluntary nerves to the pterygoid, the masseter, the temporal, and buccinator muscles.

I was induced to perform the preceding experiments on reading an essay by Mr. Bell *, in which a novel view of the functions of certain nerves is propounded; resting in part upon experiments in great measure similar to those above narrated, but differing materially in their results. As nothing is so preju-

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* Philosophical Transactions, Vol. CXI. p. 398—424.

dicial to the interests of science, as the temporary adoption of an unsound theory, I shall hazard a few remarks upon that of Mr. Bell.

Mr. Bell observes that "the nerves of the spine, the tenth, or suboccipital nerve, and the fifth or trigeminus of the system of Willis constitute the original and symmetrical system*," which is equally found "in the leech and worm:" that "these nerves have all double origins; that they have all ganglia on one of their roots; that they go out laterally to certain divisions of the body; that they do not interfere to unite the divisions of the frame; that they are all muscular nerves, ordering the voluntary movements of the frame; that they are all exquisitely sensible; and the source of the common sensibility of the surface of the body; and that when accurately represented on paper, they are seen to pervade every part†."

On the other hand, Mr. Bell observes that the par vagum, the portio dura, the spinal accessory, the phrenic, and the posterior thoracic, are "respiratory nerves;" that is to say, "they connect the internal organs of respiration with the sensibilities of remote parts, and with the respiratory muscles, and are distinguished from those, of which we have been speaking, by many circumstances. They do not arise by double

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* Philosophical Transactions, Vol. CXI. p. 404.

† Ibid. p. 404.

roots; they have no ganglions on their origins; they come off from the medulla oblongata and the upper part of the spinal marrow; and from this origin they diverge to those several remote parts of the frame, which are combined in the act of respiration *."

I shall endeavour to show, that the preceding distinction is not founded on correct observation, and that in truth the nerves, which Mr. Bell terms "respiratory," do not differ in any important respect, as a class, from those, with which he contrasts them.

1. The par vagum; this nerve has many roots, and has a ganglion near its origin. When the branches of the par vagum which pass to the larynx are divided, the voluntary movements of that organ are destroyed; the part is no longer competent to the formation of sounds, or to assist in the act of deglutition; while on the other hand, respiration is not impeded. The par vagum is acutely sensible; I exposed its trunk in the neck of an ass, and on pinching it with the forceps, the animal gave violent indications of pain.

2. The portio dura of the seventh is proved, by the experiments which I have detailed, to be a common nerve of voluntary motion: if it be divided, the muscles, which receive branches from it, are completely paralysed.

3. The spinal accessory nerve; of this Mr. Bell

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* Philosophical Transactions, Vol. CXI. p. 405.

observes, that "it controuls the muscles of the neck and shoulder in their office as respiratory muscles, when by lifting the shoulders, they take the load from the chest, and give freedom to the expansion of the thorax. When it is cut across in experiments, the muscles of the shoulder, which were in action as respiratory muscles, cease their co-operation, but remain capable of voluntary actions *."

In human beings, the only muscles of the neck and shoulder, which receive branches from the spinal accessory, are the sterno-cleido-mastoideus and the trapezius.

4. The phrenic nerve is formed of branches of four or five spinal nerves; it generally receives a fine filament or two, from the ninth pair, the par vagum, and the sympathetic.

5. The posterior thoracic nerve is formed of branches of the spinal nerves.

Mr. Bell observes further, that "there are other nerves of the same class which go to the tongue, throat, and windpipe, no less essential to complete the act of respiration. These are the glosso pharyngeal nerve, the lingual or ninth of Willis, and the branches of the par vagum to the superior and inferior larynx †."

Of the latter I have already spoken; the ninth, it is

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* Philosophical Transactions, Vol. CXI. p. 407.

† Ibid. p. 408.

commonly supposed, is the voluntary nerve of the tongue: consistently with which hypothesis I have remarked, that on pinching this nerve with the forceps in an animal recently killed, the muscles of the tongue are convulsed, which does not happen when the gustatory nerve is thus mechanically irritated. In a rabbit, in which I had divided this nerve on either side, the tongue was motionless, so that, when it was drawn out of its natural situation, and left with its extremity between the teeth, the animal did not retract the part within the mouth. This experiment obviously points to other inquiries, which I have not yet pursued to any extent.

Having stated these facts, I leave it to the reader to decide whether they are consistent with, or subversive of, Mr. Bell's theory of "Symmetrical and Respiratory Nerves," and proceed to give an account of his experiments.

These consist in the division of the portio dura on one side of the head in different animals, and of the division of the infraorbital nerves on both sides.

"An ass being thrown, and its nostrils confined for a few seconds, so as to make it pant, and forcibly dilate the nostrils at each inspiration, the portio dura was divided on one side of the head; the motion of the nostril of the same side instantly ceased, while the other nostril continued to expand and contract in unison with the motions of the chest. On the division of the nerve, the animal gave no sign of pain: there was no struggle nor effort made, when it was cut across. The animal

being untied, and corn and hay given to him, he eat without the slightest impediment *."

This experiment is inconclusive, because the nerve was not divided on both sides: had this point been attended to, a different result would probably have ensued.

"An ass being tied and thrown, the superior maxillary branch of the fifth nerve was exposed. Touching this nerve gave acute pain. It was divided, but no change took place in the motion of the nostril: the cartilages continued to expand regularly in time with the other parts, which combine in the act of respiration, *but the side of the lip was observed to hang low, and it was dragged to the other side.* The same branch of the fifth was divided on the opposite side, and the animal let loose. He could no longer pick up his corn: *the power of elevating and projecting the lip, as in gathering food, was lost.* To open the lips, the animal pressed the mouth against the ground, and at length licked the oats from the ground with his tongue. The loss of motion of the lips in eating was so obvious, that it was thought an useless cruelty to cut the other branches of the fifth †."

The first statement, printed in italics, is contrary to my own observation; the second, a theoretical account of the fact that the animal did not elevate and project

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* Philosophical Transactions, Vol. CXI. p. 413.

† Ibid.

its lip. This fact was noticed in my own experiments, but appeared to me from the first equally consistent with the hypothesis, that the lip had merely lost its sensibility, as with Mr. Bell's explanation; in which conjecture I was borne out by what occurs in cases of anæsthesia in human beings: afterwards, I was able to prove the correctness of my supposition, by the result of experiment 3.

From such experiments, however, as the two last detailed, coupled with the facts that on the division of "the branch of the fifth pair, which goes to the forehead, on account of tic douloureux, no paralysis of the muscles of theey ebrow followed; while, in an individual, where an ulcer and abscess, seated anterior to the tube of the ear, affected the superior branch of the respiratory nerve, the eyebrow fell low, and did not follow the other, when the features were animated by discourse or emotion*;" and, again, with the fact, that by the division of "a branch of the nerve, which passes to the angle of the mouth," a coachman was deprived of the power of whistling, Mr. Bell derives the following inferences:

That the nerves of the fifth pair are the "original and symmetrical nerves" of the face, imparting sensibility to it, and exciting its muscles to the prehension of food; and that "the portio dura of the seventh is

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* Philosophical Transactions, Vol. CXI. p. 416. I have in this extract transposed the words of the original.

the respiratory nerve of the face; that the motions of the lips, the nostrils, and the velum palati are governed by its influence, when the muscles of these parts are in associated action with the other organs of respiration *."

These inferences are, on the one hand, applied by Mr. Bell and Mr. Shaw, to explain the phenomena of partial paralysis of the face; and, on the other, to illustrate a principle assumed in Mr. Bell's theory, that organs, the muscles of which are employed in more than one function, are supplied with distinct nerves, to excite each separate mode of muscular action; or, as the author expresses this assumption in regard to the nerves of the face: "In reviewing the comparative anatomy of the nerves of the mouth, we shall find, that in creatures which do not breathe, the mouth having only one function to perform, one nerve is sufficient †."

It remains for the reader to decide, whether Mr. Bell's experiments are satisfactory, and bear out his inferences; whether the latter, coupled with my former

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* Philosophical Transactions, Vol. CXI. p. 414.

† Ibid. p. 402. Perhaps the most destructive mode of putting some of the preceding facts in opposition to Mr. Bell's theory, is the following:—The ass does not appear to breathe through its mouth, yet the portio dura in this animal sends branches to the lips, the division of which, and of which alone, paralyzes the muscles of its lips.

observations on the five "respiratory nerves" of this author, leave his theory tenable; and perhaps finally to determine, whether there exist in the whole of Mr. Bell's essay, after the deduction of his controvertible statements, more than one correct inference. I here allude to Mr. Bell's experimental confirmation of an opinion, which, at the beginning of the eighteenth century, occurred to Dr. Blair* on his minute examination of the proboscis of an elephant, viz. that the infraorbital nerves are nerves of touch.

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* Philosophical Transactions, abridged, Vol. V. p. 95.

THE END.

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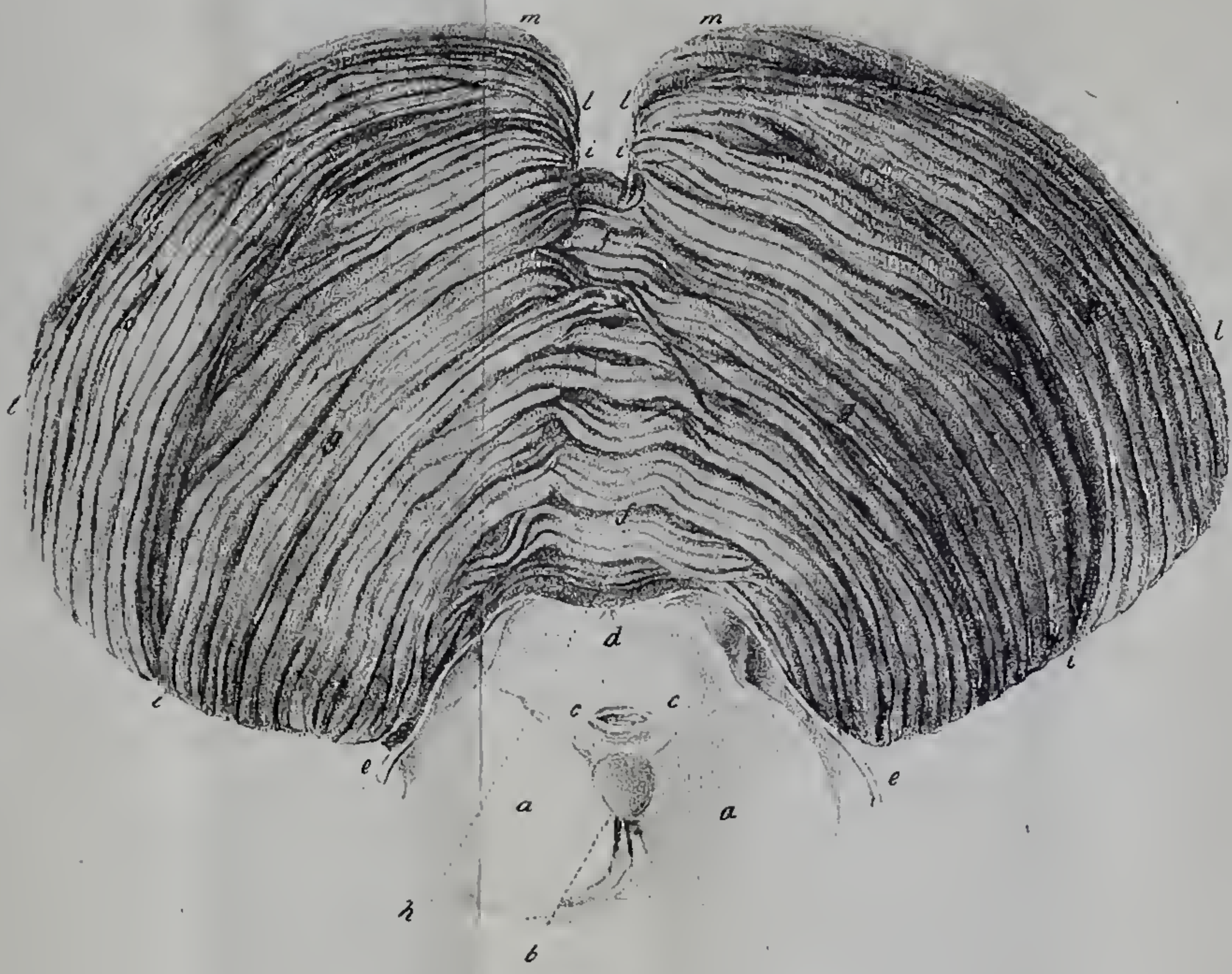
Tab. 1.

Fig. 1.



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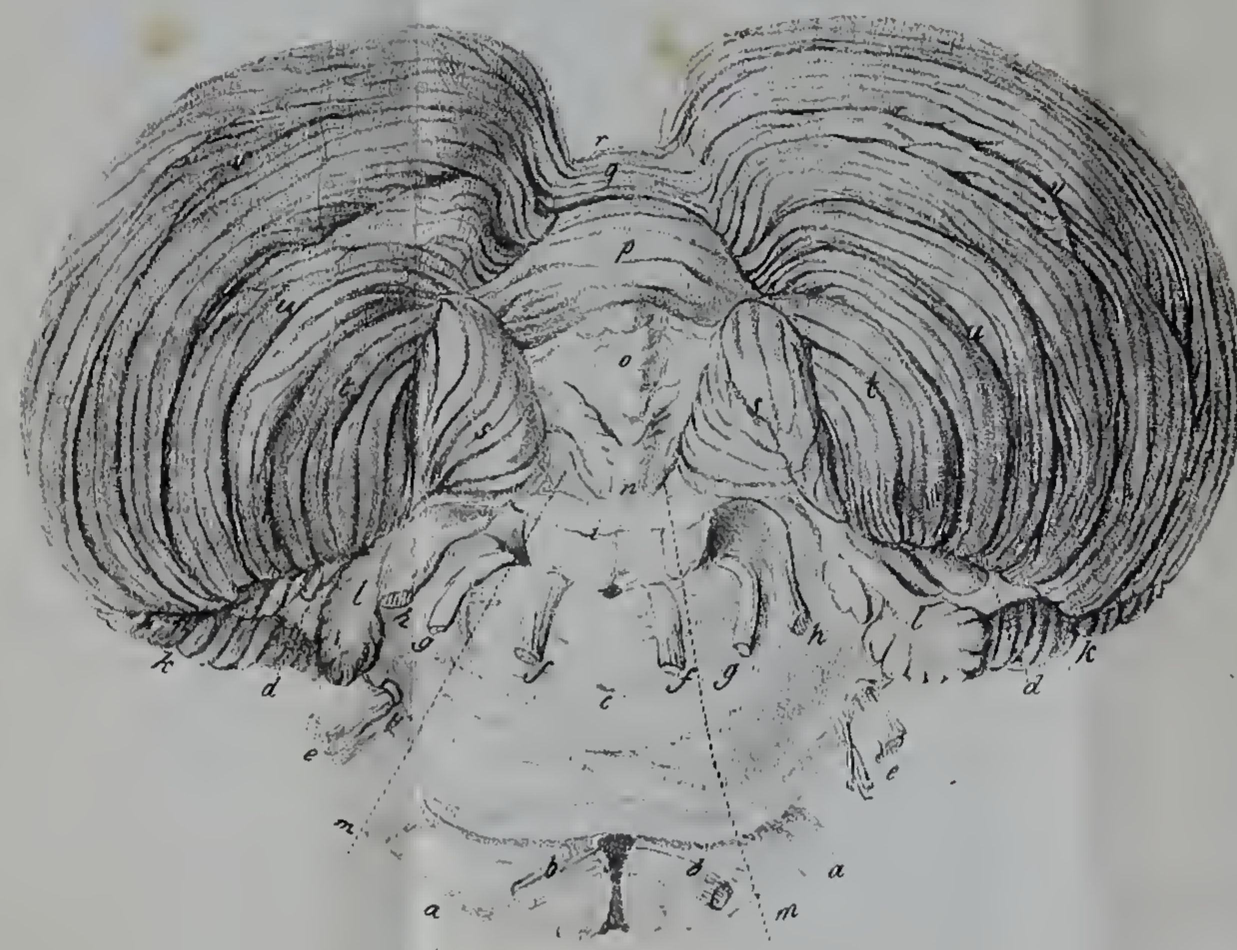

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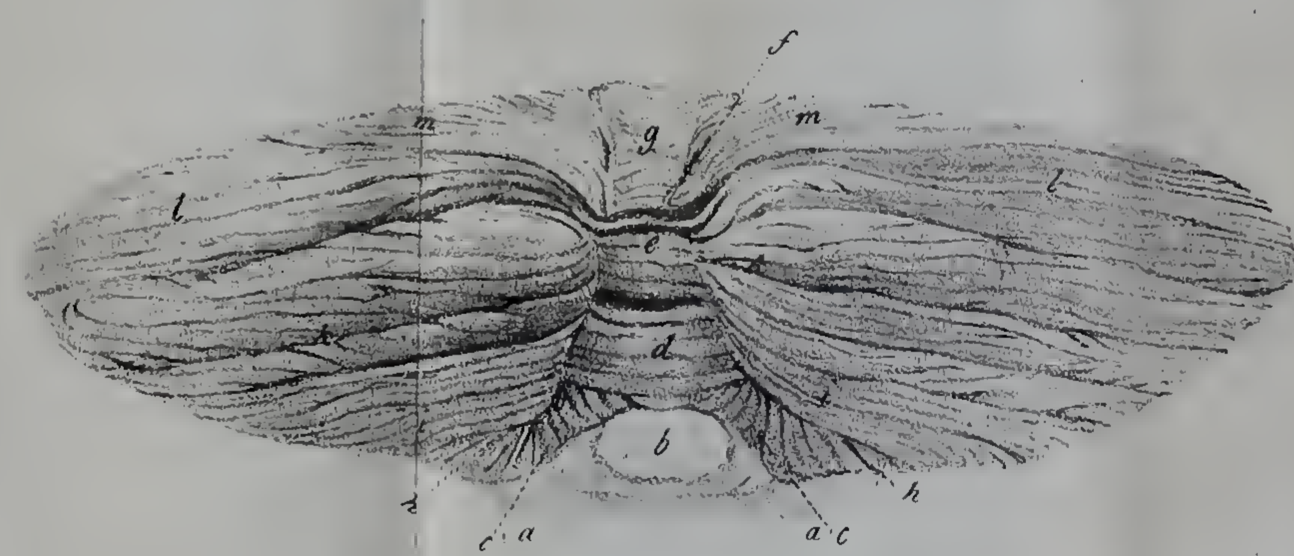

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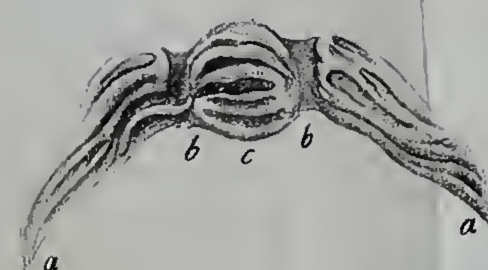

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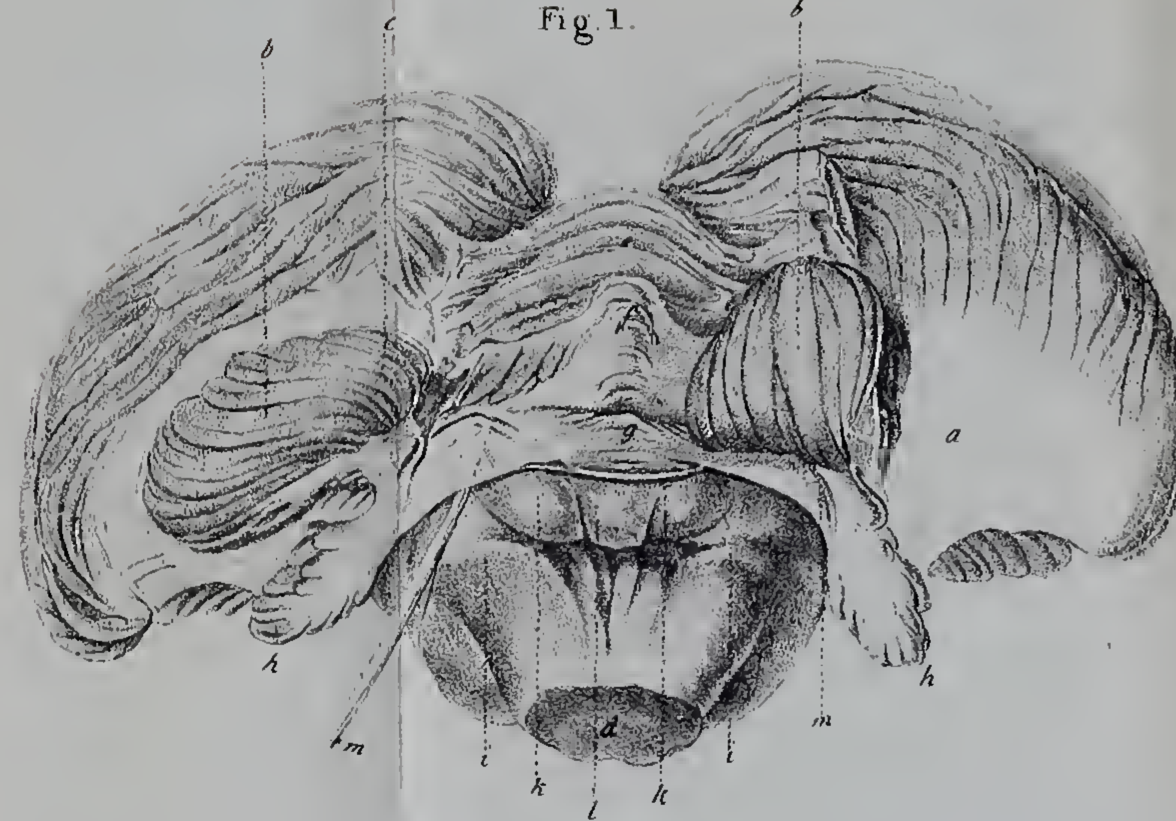

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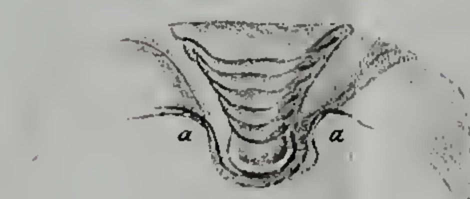

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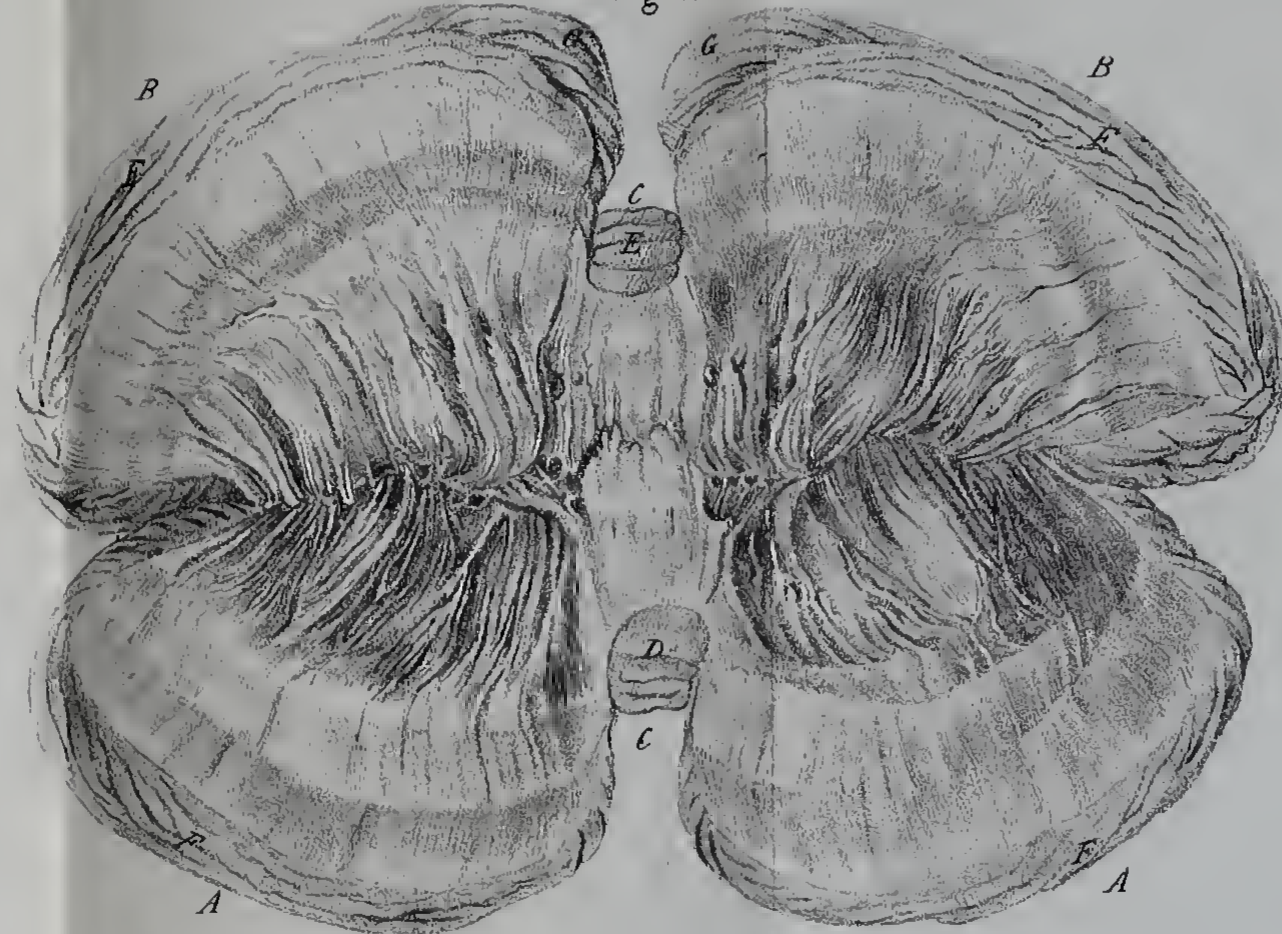
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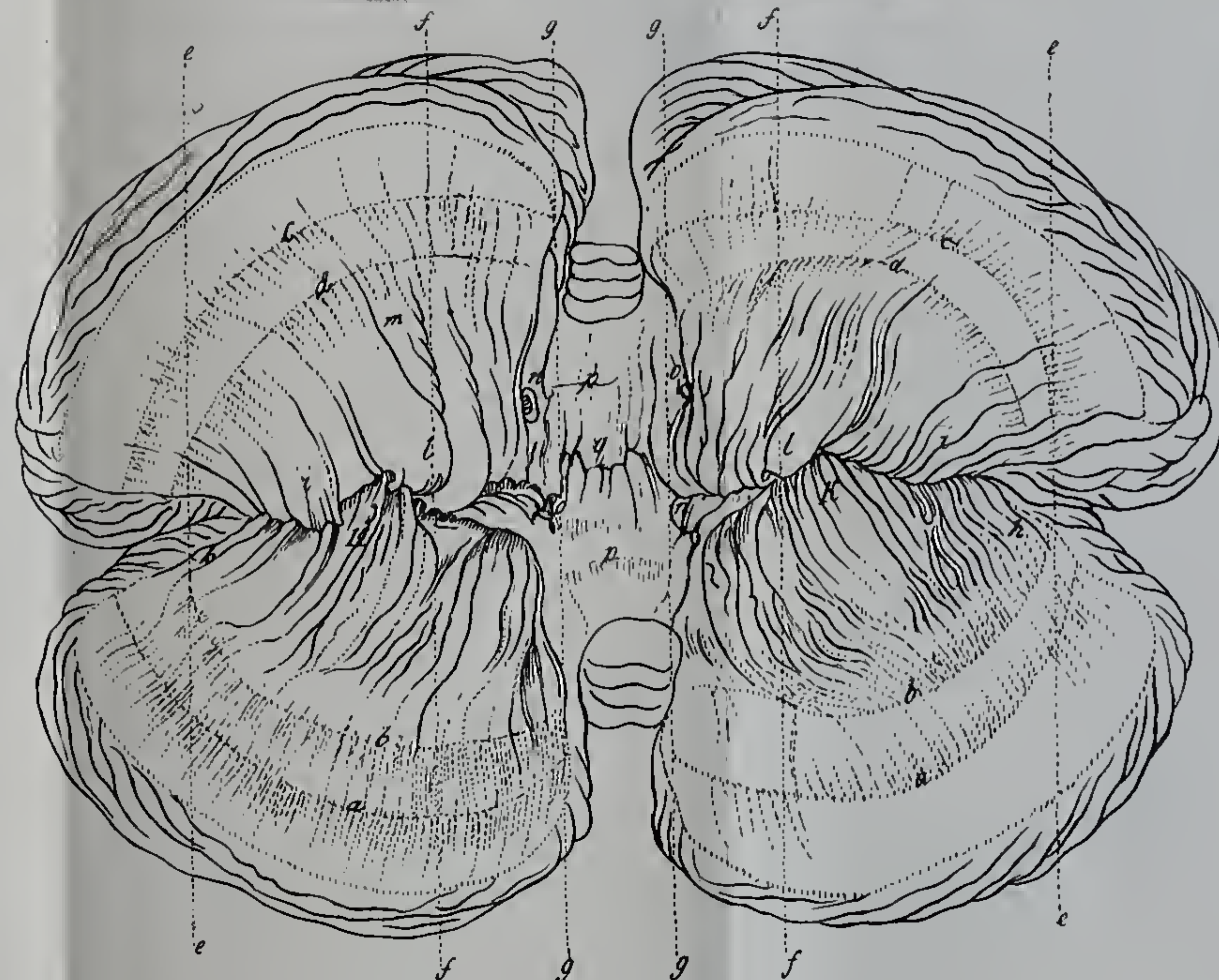
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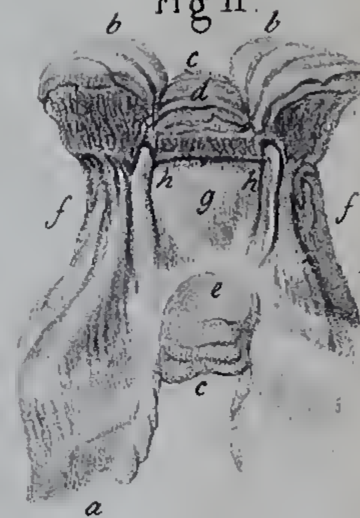
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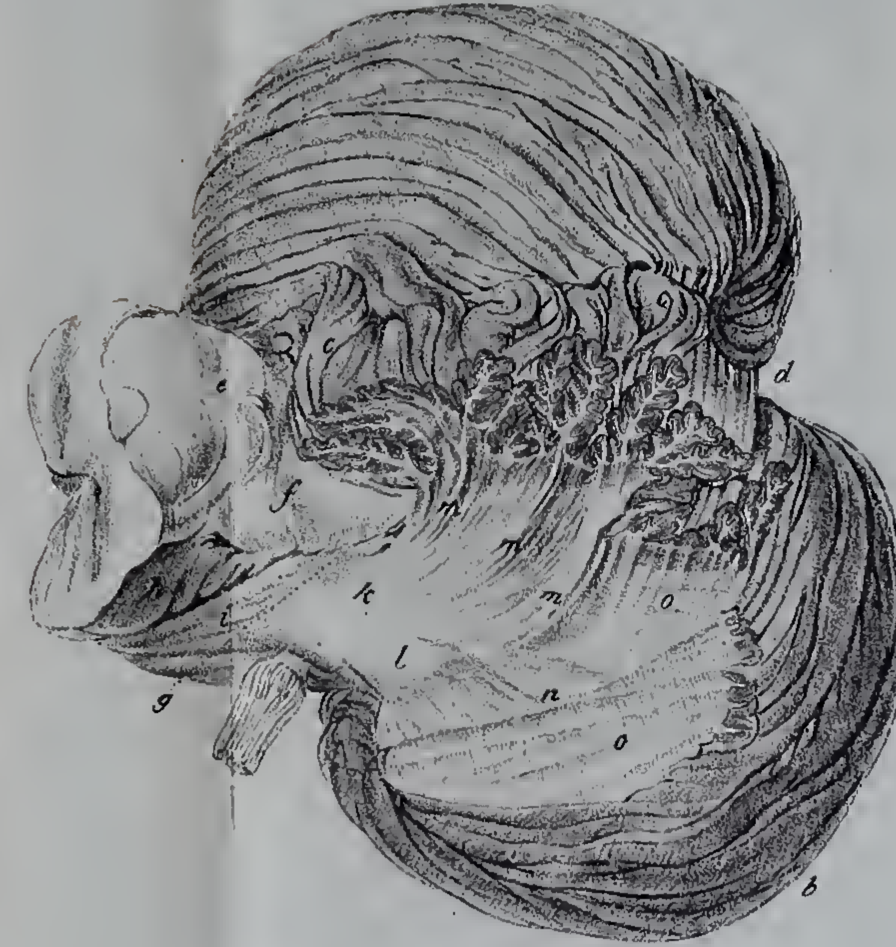

Fig. II.